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Report of BAMIRAC

PROPERTIES OF COPPER PLASMA

Calculation of the Partition Function, Species Concentration, and Spectral-Line Intensities

STUART W. BOWEN

INFRARED LABORATORY
Institute of Science and Technology
THE UNIVERSITY OF MICHIGAN

July 1964

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Department of Aeronautical and
Astronautical Engineering

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NOTICES

Sponsorship. The work reported herein was conducted by the Institute of Science and Technology for the Advanced Research Projects Agency, U. S. Department of Defense, Contract SD-91 (ARPA Order 236) as a part of Project DEFENDER (research on and defense against ballistic missiles). Contracts and grants to The University of Michigan for the support of sponsored research by the Institute of Science and Technology are administered through the Office of the Vice-President for Research.

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PREFACE

BAMIRAC, the Ballistic Missile Radiation Analysis Center, is a facility of the Institute of Science and Technology at The University of Michigan. It is supported by ARPA, the Advanced Research Projects Agency, under Contract SD-91, as a part of Project DEFENDER (research on and defense against ballistic missiles).

BAMIRAC functions as a center for analysis of and information on ballistic missiles and space vehicles, with the objective of formulating defense measures against them. Analyses of experimental and theoretical results, conducted in three general subdivisions corresponding to the launch, midcourse, and reentry phase of ballistic missile flight, are evaluated and examined for correlations. In its operation as a technical information center, BAMIRAC collects, processes, and disseminates information concerning electromagnetic radiation emanating from or caused by ICBM's or IRBM's, from reports of field measurements as well as from laboratory and theoretical results.

In addition to analyzing the results from external sources, BAMIRAC conducts its own theoretical and experimental investigations.

The results of the work within BAMIRAC are combined with the material obtained from outside sources to develop models for ballistic missile radiation. The information so obtained is disseminated in technical reports, which are published frequently. The technical content of the library holdings is made available to organizations whose representatives have proper authorization; in addition, the library prepares bibliographies on request. BAMIRAC also aids ARPA by handling various technical meetings and by publishing the Proceedings of the Anti-Missile Research Advisory Council.

BAMIRAC is under the technical direction of the Infrared Laboratory. It draws also, however, upon the capabilities of the Computation Department of the Institute, and upon those of the Aircraft Propulsion Laboratory of the Department of Aeronautical and Astronautical Engineering and of other departments of The University of Michigan, particularly within the College of Engineering.

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SYMBOLS, CONSTANTS, AND CONVERSION FACTORS

A_n^m	= Einstein transition probability from state m to n, sec^{-1}
a	= Classical semi-major axis of electron energy state, cm
a_0, a_+	Defined by Equations 56 and 58
C	Defined by Equation 42
c	= Velocity of light, 2.997929×10^{10} cm/sec
d	= Debye-Hückel (subscript)
E_m	= Term value of state m, cm^{-1}
	= Energy level of state m, ergs
e	= Electron charge, 4.80286×10^{-10} esu
g_m	= Degeneracy of state m, $2J_m + 1$
h	= Planck's constant, 6.62517×10^{-27} erg sec
I	= Intensity of spectral line, erg sec^{-1} cm^{-3} $sterad^{-1}$
J_m	= Inner quantum number of state m
k	= Boltzmann's constant, 1.38044×10^{-16} erg deg^{-1}
	= 1/1.4388 cm^{-1} deg^{-1}
K_p	= Equilibrium constant, atm
m	= Energy state
m_e	= Electron mass, 9.1083×10^{-28} g
N	= Original mole fraction of copper
n	= Total particle density
n_m	= Number density of atoms in state m, cm^{-3}
n_e	= Electron number density, cm^{-3}
n_q	= Number density of atoms in ionization state q. q = 0, 1, 2, . . .
p	= Pressure, atm
R	= Intensity ratio
T	= Temperature, $^{\circ}K$
V_q	= Energy to ionize an atom from q-th to (q + 1)-st ionization state in the plasma
x_s	= Mole fraction of species s
Z_q	= Partition function for atoms in the q-th ionization state
α	= $(2\pi m_e k)^{3/2}/h^3$ (Section 6)
β	= Z_+/Z_0
ν	= Frequency, sec^{-1}
λ_d	= Debye radius, cm
λ	= Wavelength

π = 3.14159 . . .

ζ = Effective nuclear charge in units of e

Cu I = Neutral copper

Cu II = Singly ionized copper

Conversion Factors [1]

1 ev = 1.60206×10^{-12} erg

= $8066.03\ cm^{-1}$

= $2.41814 \times 10^{14}\ sec^{-1}$

1 cm^{-1} = 1.98618×10^{-16} erg

= 12397.67×10^{-8} ev

1 sec^{-1} = 6.62517×10^{-27} erg

= 4.13541×10^{-15} ev

1 erg = $1.50940 \times 10^{26}\ sec^{-1}$

= $5.03479 \times 10^{15}\ cm^{-1}$

1 atm = 1.013246×10^{6} dynes cm^{-2}

Constants for Copper [7], [8]

For Cu I λ 5105.54

$g_m A_n^m$ = $.051 \times 10^{8}\ sec^{-1}$

E_m = $30783.7\ cm^{-1}$

For Cu I λ 5153.24

$g_m A_n^m$ = $4.7 \times 10^{8}\ sec^{-1}$

E_m = $49935.2\ cm^{-1}$

Ionization potential for Cu I

= 7.72588 ev

= $62317.2\ cm^{-1}$

Ionization potential Cu II

= 20.2907 ev

= $163665.6\ cm^{-1}$

PROPERTIES OF COPPER PLASMA
Calculation of the Partition Function, Species Concentration, and Spectral-Line Intensities

ABSTRACT

The self-consistent partition function; ionization potential lowering; electron, ion, and neutral-particle species concentrations; and the absolute spectral-line intensities of Cu I λ 5106 and Cu I λ 5153 are reviewed and tabulated for pressures between 0.03 and 10 atm, for original mole fractions between 10^{-4} and 0.03 and for temperatures from 2000° to 10,000°K, for copper vapor in a hot inert gas at thermal equilibrium. Only single ionization of copper is considered in this range of conditions. For the partition function cutoff, all electron states whose classical semi-major axis exceeds one-half the Debye distance are suppressed. The results should be of use in spectroscopic plasma diagnostics and other situations where the trace amounts of copper usually present can be used for temperature measurement.

1
INTRODUCTION

For the determination of temperature and other physical properties within a plasma, spectroscopic methods are of great interest and value [2, 3, 4].

In this report the formulas necessary to calculate species concentration and spectral line intensities are reviewed and then applied to copper vapor in an inert gas. These calculations, while straightforward for atomic spectral lines in optically thin plasmas, are rather tedious, particularly in view of the iteration necessary even for this rather simplified case; therefore a digital computer was used.

In order to make meaningful estimates of the required sensitivity of photomultipliers, amplifiers, and other light detectors, it is necessary to have quantitative information on the intensity of radiation that will be measured for the range of temperatures, pressures, and mole fractions that are expected.

The intensities of the spectral lines Cu I λ 5106 and Cu I λ 5153 are calculated for the idealized case of copper vapor in a hot inert gas. All electrons are presumed to originate from the single ionization of copper. Double ionization of copper has been neglected for the range of conditions covered here. This assumption gives an error of less than 1/2% at 10,000°K.

The partition functions for Cu I and Cu II, ionization potential lowering, Debye radius, and species concentrations are also tabulated. This allows computation of other copper spectral line intensities if values for their transition probabilities are known.

It should be possible to use the calculations to help determine contamination levels of copper electrode material introduced in plasma jets, as well as temperatures within the plasma.

The internal partition function tabulation will permit calculation of the contribution of the internal degrees of freedom to the various thermodynamic functions.

2
FUNDAMENTAL EQUATIONS

2.1. INTENSITY OF AN ATOMIC SPECTRAL LINE

The radiant power from a spectral line emitted in all directions (4π sterad) from a unit volume of gas, arising from a transition between two energy states of an atom, is equal to the product of the number of transitions per unit time between the two states, and the energy change involved in the transition between the two states.

The number of transitions per second between an upper state m and a lower state n is given by the product of the number of atoms per cm^3 in the upper state m, and the transition probability per second from state m to state n.

If the number density of atoms in the upper state m is n_m cm^{-3}, and the transition probability between upper state m and lower state n is A_n^m sec^{-1}, then the number of transitions per second between upper state m and lower state n is

$$n_m A_n^m \quad cm^{-3}\ sec^{-1}$$

The energy change of the transition between an upper state of energy E_m and a lower state of energy E_n is given by

$$E_m - E_n = h\nu \quad ergs$$

where ν is the frequency of emitted radiation and h is Planck's constant.

Therefore, the radiant intensity per cm^3 of gas emitted into 1 sterad from a spectral line is [4]

$$I = \frac{1}{4\pi} h\nu A_n^m n_m \quad erg\ sec^{-1}\ cm^{-3}\ sterad^{-1} \tag{1}$$

At thermal equilibrium, the number density of particles in energy state l, compared to the number density of particles in energy state m, is given by the Boltzmann energy distribution as [5, 6]

$$\frac{n_l}{n_m} = \frac{g_l}{g_m} \frac{e^{-E_l/kT}}{e^{-E_m/kT}}$$

where g is the statistical weight or degeneracy of energy level E_l, and k is the Boltzmann constant. Summing n_l over all energy levels in the same ionization state, we find the number density of atoms in the q-th state of ionization to be [4, 5]

$$n_q = \sum_l n_l = \frac{n_m}{g_m e^{-E_m/kT}} \sum_l g_l e^{-E_l/kT}$$

$$= \frac{n_m Z_q}{g_m e^{-E_m/kT}} \text{ cm}^{-3} \qquad (2)$$

where

$$Z_q = \sum_l g_l e^{-E_l/kT} \qquad (3)$$

is the internal partition function for atoms in the q-th state of ionization. Therefore,

$$n_m = \frac{n_q g_m e^{-E_m/kT}}{Z_q} \text{ cm}^{-3} \qquad (4)$$

Substituting Equation (4) into Equation (1), we find [4]

$$I = \frac{n_q h\nu}{Z_q} \frac{g_m A_n^m e^{-E_m/kT}}{4\pi} \text{ erg sec}^{-1} \text{ cm}^{-3} \text{ sterad}^{-1} \qquad (5)$$

Values of E_m are tabulated in Reference 7, and values of $g_m A_n^m$ can be found in Reference 8. Other compilations and bibliographies of transition probabilities can be found in References 9, 10, and 11.

2.2. SAHA EQUATION

For a given element, the number density of atoms in successive ionization states at thermal equilibrium is given by the Saha Equation [4, 12, 13]:

$$\frac{n_{q+1} n_e}{n_q} = \frac{2Z_{q+1}}{Z_q} \frac{(2\pi m_e kT)^{3/2}}{h^3} e^{-V_q/kT} \tag{6}$$

where n_q = number density of atoms in the q-th ionization state, cm^{-3}

n_e = number density of electrons, cm^{-3}

Z_q = partition function for atoms in q-th ionization state

m_e = electron mass

V_q = ionization energy necessary to ionize an atom from the q-th state of ionization to the (q + 1)-st ionization state within the plasma.

Note that the mass of the atom in the q-th state of ionization, m_q, has been taken equal to m_{q+1} and $Z_e = 2$.

Considering single ionization of neutral atoms (q = 0), Equation 6 becomes

$$\frac{n_+ n_e}{n_0} = \frac{2Z_+}{Z_0} \frac{(2\pi m_e kT)^{3/2}}{h^3} e^{-V_0/kT} \tag{7}$$

Within the plasma we have charge neutrality [14]

$$n_e = \sum_q q n_q \tag{8}$$

where the sum is taken over all ionization states, q = 0, 1, 2, ...

Equations 5, 6, and 8 are the fundamental equations necessary for the calculation of species concentration and spectral-line intensities. They can be manipulated in several ways for convenience in a particular application.

3
COPPER SPECTRAL LINES, Cu I λ 5106 AND Cu I λ 5153

The Cu I λ 5106 and Cu I λ 5153 lines are of interest here for the following reasons:

1. Their wavelengths are nearly equal, which will minimize problems of spectral sensitivity of a detector.

2. Their upper energy levels have relatively large differences, so that the population ratio of these levels is a relatively strong function of temperature, through the Boltzmann factor.
3. Neither line is a ground-state transition; thus problems of self-reversal of the central radiation by the relatively cold outer atoms is avoided.
4. They have relatively well-determined transition probabilities.
5. They arise from neutral copper atoms so that partition functions do not enter into their relative intensity.
6. They have reasonable intensities and intensity ratios for temperatures in the range 3000° to 10,000°K.

The intensity ratio of these two lines is calculated below. Their absolute values are tabulated in the appendix, having been calculated from Equation 5.

The intensity ratio of two lines, 1 and 2, arising from an atom in the same ionization state ($n_{01} = n_{02}$, $Z_{01} = Z_{02}$) is, from Equation 5,

$$\frac{I_1}{I_2} = \frac{\nu_1}{\nu_2} \frac{g_{m1} A^m_{n1}}{g_{m2} A^m_{n2}} \exp\left(-\frac{E_{m1} - E_{m2}}{kT}\right) \tag{9}$$

so that

$$\log \frac{I_1}{I_2} = \log \frac{\nu_1}{\nu_2} + \log \frac{\left(g_m A^m_n\right)_1}{\left(g_m A^m_n\right)_2} - \frac{E_{m1} - E_{m2}}{kT} \log e$$

Assuming the index of refraction for the two wavelengths as measured in air is nearly constant, then

$$\nu_1/\nu_2 = \lambda_2/\lambda_1$$

If E_m is measured in cm^{-1}, then

$$\log \frac{I_1}{I_2} = \log \frac{\left(g_m A^m_n\right)_1}{\left(g_m A^m_n\right)_2} - \log \frac{\lambda_1}{\lambda_2} - \frac{0.624856(E_{m1} - E_{m2})}{T} \tag{10}$$

For Cu I [7, 8] (see also constants in Symbols List),

$$\lambda_1 = 5153.24$$

$$\lambda_2 = 5105.54$$

$$(gA)_1 = 4.7 \times 10^8 \text{ sec}^{-1}$$

$$(gA)_2 = .051 \times 10^8 \text{ sec}^{-1}$$

$$E_{m1} = 49935.2 \text{ cm}^{-1}$$

$$E_{m2} = 30783.7 \text{ cm}^{-1}$$

If we denote L/I_2 by $[\lambda\ 5153 \text{ Cu I}]/[\lambda\ 5106 \text{ Cu I}]$, Equation 10 becomes

$$\log\left[\frac{\lambda\ 5153 \text{ Cu I}}{\lambda\ 5106 \text{ Cu I}}\right] = 1.96049 - \frac{11966.9}{T} \tag{11}$$

We can also write this as

$$T = \frac{11966.9}{1.96049 - \log\left[\frac{\lambda\ 5153 \text{ Cu I}}{\lambda\ 5106 \text{ Cu I}}\right]} \tag{12}$$

Figure 1 is a plot of Equation 11.

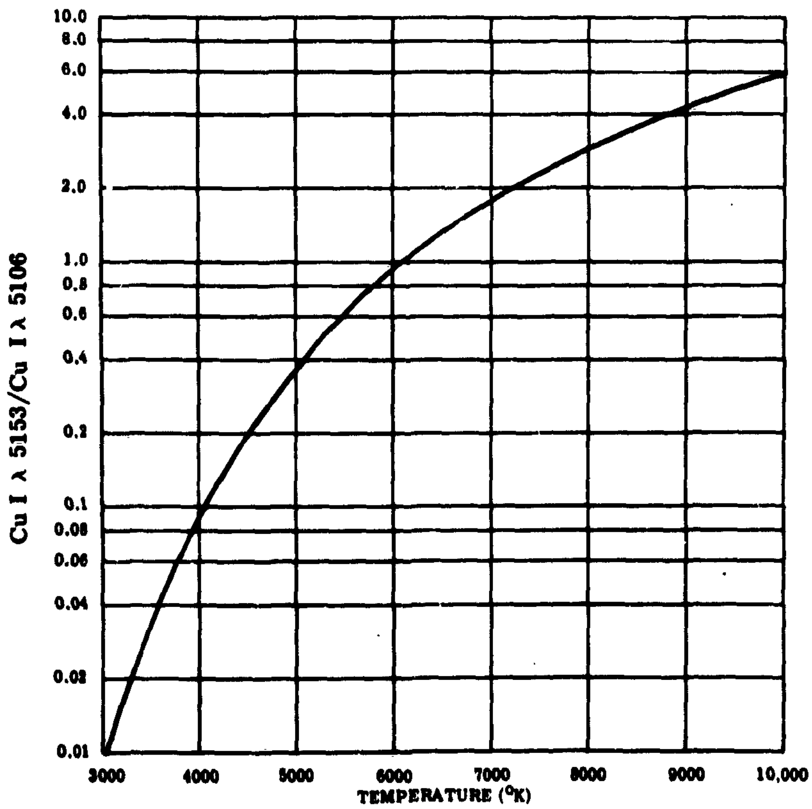

FIGURE 1. INTENSITY RATIO VS. TEMPERATURE

4
IONIZATION-POTENTIAL LOWERING AND TRUNCATION OF THE PARTITION FUNCTION SUM

Because of the interaction of an atom with the nearby particles in a plasma, the ionization potential will be lowered for a particle inside a plasma. Physically, an excited atom inside a plasma can spontaneously ionize because of the perturbation of its neighbors if its energy state is between this lowered ionization potential and the ordinary ionization limit of an unperturbed atom.

Coupled with the physical process described above is the observation that for large temperatures the exponential factor in the internal partition function sum (Equation 3)

$$Z = \sum_K g_K e^{-E_K/kT}$$

approaches unity, allowing the sum to diverge as more and more terms are taken. The degeneracy g of the state having principle quantum number n is $2n^2$ [15]. A method for avoiding this difficulty is to truncate the partition function sum. The amount that the energy level of the last term taken in the truncated sum lies below the ordinary ionization limit corresponds to the lowering of the ionization potential.

Several criteria have been put forward as to where to truncate the partition function and how much to lower the ionization potential [4, 16, 17]. The actual value of the partition function is rather insensitive to the particular cutoff criterion used. The partition function sum will be truncated when the classical semimajor axis of the electron orbit is greater than or equal to one-half the Debye screening distance. The results obtained here by physical reasoning agree with the Debye-Hückel theory for dilute plasmas [18]. Good experimental confirmation of this Debye distance-truncation criterion for argon plasmas has been shown [19].

The semimajor axis of a classical electron orbit is [15]

$$a = \frac{\zeta e^2}{2W} \text{ cm} \tag{13}$$

where ζ is the effective nuclear charge ($\zeta = 1$ for atoms, $\zeta = 2$ for singly ionized ions, etc.), e is the electron charge, and W is the energy of the electron state in ergs measured downward from the ionization limit. If we measure energies upward from the ground state, which lies

W_{ion} below the ionization limit, we replace W by W_{ion} - W. Replacing energies W measured in ergs by term values E measured in cm^{-1}, E = W/hc

$$a = \frac{\zeta e^2}{2hc(E_{ion} - E)} \tag{14}$$

Evaluating constants we find

$$a = \frac{5.80699 \times 10^{-4}}{E_{ion} - E} \zeta \quad cm \tag{15}$$

as the semimajor axis of a state having term value E of an atom with ionization term value E_{ion}.

The Debye radius is given by [14, 18]

$$\lambda_d = \sqrt{\frac{kT}{4\pi e^2\left[n_e + \sum n_i(\zeta_i - 1)^2\right]}} = 6.90087 \sqrt{\frac{T}{n_e + \sum n_i(\zeta_i - 1)^2}} \tag{16}$$

since we are considering the screening of a stationary charge. The sum is over all the positive-ion species. If only singly charged ions are present, $n_e = n_+$

$$\lambda_d = 4.87965 \sqrt{T/n_e} \tag{17}$$

If we denote by E_d the term value of a state having classical semimajor axis a = $\lambda_d/2$, then from Equation 15

$$E_{ion} - E_d = \frac{1.16140 \times 10^{-3}}{\lambda_d} \zeta \quad cm^{-1} \tag{18}$$

Note that E_d may not correspond to any actual term value of the particle. Since 1 cm^{-1} = 1.23977×10^{-4} ev, the ionization potential lowering is [18]

$$\Delta V = 1.23977 \times 10^{-4}(E_{ion} - E_d) = \frac{1.43987 \times 10^{-7}}{\lambda_d} \zeta \quad ev \tag{19}$$

For plasmas having only single-charged ions present,

$$\Delta V = 2.95075 \times 10^{-8} \sqrt{n_e/T}\, \zeta \quad ev \tag{20}$$

where $\zeta = 1$ for the atoms and $\xi = 2$ for the positive ions. The ionization potential for a neutral atom inside the plasma is therefore

$$V_{ion} = V_0 - 2.95075 \times 10^{-8} \sqrt{n_e/T} \quad \text{ev} \tag{21}$$

The Debye-Hückel pressure is [18, 19]

$$p_d = -\frac{kT}{24\pi\lambda_d^3} \tag{22}$$

For single ionization, using Equation 17,

$$p_d = -1.55517 \times 10^{-26} \frac{n_e^{3/2}}{T} \quad \text{atm} \tag{23}$$

The total pressure is

$$p = nkT - \frac{kT}{24\pi\lambda_d^3} \tag{24}$$

where n is the total particle density.

5
PARTITION FUNCTION FOR COPPER I AND II

Knowledge of the partition function, (Equation 3),

$$Z = \sum_m g_m e^{-E_m/kT}$$

for a substance enables us to calculate all thermodynamic properties of interest, using statistical thermodynamics [5, 6, 20].

Because of the dependence of spectral-line intensities upon the populations of the various energy levels, the partition function enters directly (Equation 5) into the calculation of these line intensities.

The calculation of the internal partition function is not difficult but is rather tedious for elevated temperatures where large numbers of energy states must be taken into account and an iterative procedure followed for an accurate calculation.

As noted in Section 4, the degeneracy of a state with principal quantum number n is $2n^2$. Examination of the number of energy levels listed by Moore [7] shows that many may be missing.

No attempt was made in the work reported here to use isoelectronic sequences [7, 17, 21] to add them.

Levels above the first ionization limit for Cu I, at 62317.2 cm^{-1}, were neglected. Lines arising from states above this limit are quite broad [22] because of the short lifetimes. Spontaneous ionization has a high probability, and for the purposes of the partition-function calculation an atom in these states was considered as ionized. This point requires further study.

Figure 2 is a plot of the internal partition function of Cu I and Cu II; the data are taken from the appendix. The values of the partition functions are functions of temperature alone for the range of conditions covered here.

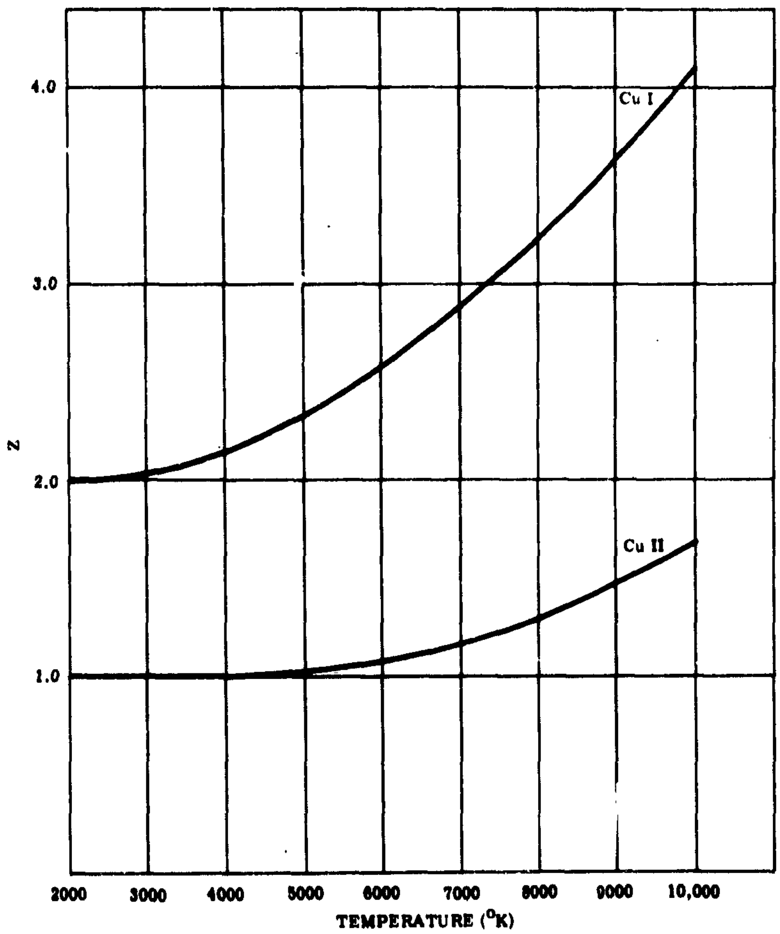

FIGURE 2. INTERNAL PARTITION FUNCTION

6
SINGLE IONIZATION OF AN ELEMENT IN AN INERT DILUENT

Consider 1 mole of element M undergoing the ionization reaction

$$M \rightleftharpoons M^+ + e^- \tag{25}$$

together with α moles of an inert diluent X. The reaction is written

$$\alpha X + M \rightarrow \alpha X + aM + bM^+ + ce^- \tag{26}$$

where a, b, c are the moles of M, M^+, e^-, respectively, at equilibrium.

We assume each species acts as a perfect gas, with partial pressure of species s given by [5]

$$p_s = x_s p \tag{27}$$

where x_s is the mole fraction of species s and p is the total pressure.

The equilibrium constant K_p is written [5]

$$K_p = \frac{p_e p_+}{p_M} = \frac{x_e x_+}{x_M} p \tag{28}$$

where p is the total pressure in atmospheres, due to particles.

Let N = original mole fraction of species M

$$N = \frac{1}{1 + \alpha} \tag{29}$$

We require charge neutrality, so

$$b = c \tag{30}$$

The total number of moles at equilibrium is

$$\alpha + a + b + c = M_T \tag{31}$$

Conserving total mass of species M,

$$M = aM + bM^+ \tag{32}$$

Assuming $M = M^+$, i.e., the atomic mass of species M equals the ionic mass of species M^+, Equation 32 becomes

$$1 = a + b \tag{33}$$

The total number of moles, Equation 31, becomes, from Equations 29, 30, 31, and 33,

$$M_T = \frac{1}{N} + b \tag{34}$$

at equilibrium. The neutral mole fraction is

$$x_M = \frac{a}{M_T} = \frac{1 - b}{(1/N) + b} \tag{35}$$

and the ionized mole fraction is

$$x_+ = \frac{b}{M_T} = \frac{b}{(1/N) + b} \tag{36}$$

$$x_+ = x_e \tag{37}$$

by Equation 30. Let $x_+ = x_e = x$, and solving Equation 36 for b,

$$b = \frac{x}{N(1 - x)} \tag{38}$$

so that Equation 35 becomes

$$x_M = \frac{1 - \frac{x}{N(1 - x)}}{\frac{1}{N} + \frac{x}{N(1 - x)}} = N - (N + 1)x \tag{39}$$

Substituting Equation 39 into Equation 28 yields

$$K_p = \frac{x^2 p}{N - (N + 1)x}$$

Solving for x and taking the positive square root since $x > 0$, we find

$$x = \frac{K_p(N + 1)}{2p}\left[\sqrt{1 + \frac{4pN}{K_p(N + 1)^2}} - 1\right] \tag{40}$$

Whenever

$$C = \frac{4pN}{K_p(N + 1)^2} << 1 \tag{41}$$

Equation 40 can be written

$$x = \frac{2N}{N + 1}\left[\frac{1}{2} - \frac{1}{8}C + \frac{1}{16}C^2 + \ldots\right] \tag{42}$$

The neutral mole fraction is then given by Equation 39.

The inert mole fraction is obtained using

$$x_\alpha = 1 - (x_+ + x_e + x_M) \tag{43}$$

To obtain K_p we proceed as follows. The Saha equation (Equation 7) becomes

$$\frac{n_+ n_e}{n_M} = \frac{(2\pi m_e kT)^{3/2}}{h^3} \frac{2Z_+}{Z_m} e^{-V_0/kT} \tag{44}$$

where V_0 is the lowered ionization potential of the neutral atom, n_+, n_e, n_M are the number densities of ions, electrons, and neutral atoms, and Z_+, Z_M are the internal partition functions of ions and neutral atoms.

Using the perfect gas law for the partial pressure of species s [5],

$$p_s = n_s kT \tag{45}$$

We can rewrite Equation 44 as

$$\frac{p_+ p_e}{p_M} = (2\pi m_e)^{3/2} \left[\frac{(kT)^{5/2}}{h^3}\right] \frac{2Z_+}{Z_m} e^{-V_0/kT} \quad \text{dynes cm}^{-2} \tag{46}$$

to have the same form as Equation 28. Changing pressure units in Equation 46 from dynes cm^{-2} to atmospheres, and evaluating constants gives

$$K_p = (3.28976 \times 10^{-7}) T^{5/2} \frac{2Z_+}{Z_M} e^{-11605.4 V_0/T} \tag{47}$$

where K_p has units of atmosphere, T is measured in ^oK and V_0 is measured in electron volts. We can also write Equation 47 in the form

$$\log K_p = -6.48284 + \frac{5}{2} \log T + \log\left(\frac{2Z_+}{Z_M}\right) - 5040.16 \frac{V_0}{T} \tag{48}$$

The total pressure is given by Equation 24:

$$p = nkT - \frac{kT}{24\pi\lambda_d^3}$$

Noting that $n_e = x_e n$, and evaluating constants, we can rewrite Equation 24:

$$0.734002 \times 10^{22} \frac{p}{T} + 1.14150 \times 10^{-4} \left(\frac{nx_e}{T}\right)^{3/2} - n = 0 \tag{49}$$

Since the Debye-Hückel correction must be small to be valid, an approximate root of Equation 49 is given by

$$n = p/kT = (0.734002 \times 10^{22})p/T \tag{50}$$

This estimate may be improved using Newton's method. Thus

$$n_{j+1} = n_j \frac{[(0.734002 \times 10^{22})p/T] + \left[1.1415 \times 10^{-4}(x_e n_j/T)^{3/2}\right] - n_j}{(1.71225 \times 10^{-4})(x_e/T)^{3/2}\sqrt{n_j} - 1} \tag{51}$$

where n_{j+1} is the improved value for the root n of Equation 49, using the results of the j-th approximation, n_j.

After satisfactory convergence of Equation 51 has given a value of n, the electron density is given by

$$n_e = x_e n \tag{52}$$

from which the Debye radius and ionization-potential lowering Equation 19 can be computed, since the temperature is known.

7 APPLICATION OF SPECTRAL-LINE INTENSITY MEASUREMENT TO TEMPERATURE AND COMPOSITION DETERMINATION

As a simple illustration we consider the single ionization of an easily ionized impurity in an inert carrier gas. We shall measure an impurity atom to impurity atom line ratio R_0 and an impurity atom to impurity ion line ratio R_+. The subscript zero denotes the neutral state, and the subscript plus the ionized state. Let the two neutral atomic lines arise from transitions with upper upper levels E_{m1} and E_{m2}; the ionic line has upper level E_{m+}. We shall assume the values of ν, $g_m A_n^m$, and E_m are known and that $Z_0(T)$, $Z_+(T)$ are known functions of the temperature T.

From Equation 5: the line-intensity ratios are

$$R_0 = \frac{I_1}{I_2} = \frac{\nu_1 \left(g_m A_n^m\right)_1}{\nu_2 \left(g_m A_n^m\right)_2} \exp\left[-\frac{(E_{m1} - E_{m2})}{kT}\right] \tag{53}$$

and

$$R_+ = \frac{I_1}{I_+} = \frac{n_0}{n_+}\frac{\nu_1}{\nu_+}\frac{\left(g_m A_n^m\right)_1}{\left(g_m A_n^m\right)_+}\frac{Z_+}{Z_0} \exp\left\{-\frac{[E_{m1} - (E_{m+} + V_0)]}{kT}\right\} \tag{54}$$

where V_0 is the impurity ionization energy. Note that E_{m+} is measured with respect to the ground state of the ion which lies V_0 above the ground state of the atom. If

$$\alpha = \frac{(2\pi m_e k)^{3/2}}{h^3} = 2.41469 \times 10^{15} \tag{55}$$

then from the Saha equation (Equation 7) and Equation 8,

$$\frac{n_+^2}{n_0} = \frac{2Z_+}{Z_0} \alpha T^{3/2} e^{-V_0/kT} \tag{56}$$

Equations 53, 54, and 56 constitute three equations in the three unknowns, n_0, n_+ and T. If

$$a_0 = \frac{\nu_1 \left(g_m A_n^m\right)_1}{\nu_2 \left(g_m A_n^m\right)_2} \tag{57}$$

$$a_+ = \frac{\nu_1 \left(g_m A_n^m\right)_1}{\nu_+ \left(g_m A_n^m\right)_+} \tag{58}$$

$$\beta = Z_+/Z_0 \tag{59}$$

and Equation 53 is solved for T,

$$T = \frac{E_{m1} - E_{m2}}{k \ell n \left(a_0/R_0\right)} \tag{60}$$

Equation 54 then becomes

$$R_+ = \frac{n_0 a_+}{n_+} \beta e^{-(E_{m1} - E_{m+} - V_0)/kT} \tag{61}$$

and Equation 56 becomes

$$\frac{n_+^2}{n_0} = 2\alpha\beta T^{3/2} e^{-V_0/kT} \tag{62}$$

From Equations 61 and 62, we find the impurity ion density to be

$$n_+ = \frac{2\alpha R_+ T^{3/2}}{a_+} e^{-(E_{m+} - E_{m1} + 2V_0)/kT} \tag{63}$$

In view of the charge neutrality

$$n_+ = n_e \tag{64}$$

The neutral impurity density is

$$n_0 = \frac{n_+^2 e^{V_0/kT}}{2\alpha\beta T^{3/2}} \tag{65}$$

A further measurement of a carrier gas-impurity atom line ratio R_c would give

$$R_c = \frac{I_c}{I_0} = \frac{n_c}{n_0}\frac{Z_0}{Z_c} a_c e^{-(E_{mc} - E_{m1})/kT} \tag{66}$$

where the subscript c = carrier and

$$a_c = \frac{\nu_c\left(g_m A_n^m\right)_c}{\nu_1\left(g_m A_n^m\right)_1} \tag{67}$$

Since T is known from Equation 60,

$$n_c = \frac{R_c n_0 Z_c}{a_c Z_0} e^{(E_{mc} - E_{m1})/kT} \tag{68}$$

The pressure is

$$p = (n_c + n_0 + n_+ + n_e)kT \tag{69}$$

The mole fraction of neutral impurity is

$$x_0 = \frac{n_0}{n_0 + n_+ + n_c + n_e} \tag{70}$$

and the mole fraction of impurity ions is

$$x_+ = \frac{n_+}{n_0 + n_+ + n_c + n_e} = x_e \tag{71}$$

The total mole fraction of impurity is $x_+ + x_0$.

Note that the assumption of thermal equilibrium permitted the same temperature to be used in all equations. Note also that E_{mc} and E_{m1} must be referred to a common zero.

8
METHOD OF CALCULATION

Equations 3, 16, 20, 40, 48, and 51 were programmed for an IBM 7090 in MAD (23), according to the following scheme. The pressure, temperature, and original mole fraction were read. The partition functions for Cu I and Cu II were calculated by truncating the partition-function sum when the terms became less than 10^{-6}. From these trial partition functions, a trial K_p was calculated, assuming no ionization potential lowering. This trial K_p permitted a preliminary calculation of n_e, E_d, and λ_d. These values were used to re-evaluate the partition functions, and the sum was truncated when the terms became less than 10^{-6} or the term values were higher than the lowered ionization potential. Second values of K_p, n_e, λ_d, and lowered ionization potential were then obtained. When successive iteration of this process resulted in a fractional change in λ_d of less than 10^{-5}, satisfactory convergence was assumed and the rest of the particle densities and spectral-line intensities were calculated. New values of pressure, temperature, and mole fractions were read, and the process was repeated.

Appendix
COMPUTER PROGRAM AND TABULATION

Values of the internal partition function (Equation 3) for neutral copper (Cu I) and singly ionized copper (Cu II), the ionization-potential lowering of Cu I, Debye radius (Equation 17), Debye pressure correlation (Equation 22), equilibrium constant (Equation 47), particle-number densities, and absolute spectral-line intensities for Cu I λ 5106 and Cu I λ 5153 are presented as functions of temperature, original mole fraction, and total pressure.

$$2000 < T < 10{,}000^{\circ}K$$
$$0.03 < p < 10 \text{ atm}$$
$$0.0001 < N < 0.03$$

The number $.2002 \times 10^{1}$ is printed out as .2002E01, and $.1192 \times 10^{-1}$ is printed out as .1192E-01.

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.72850E-01	-.93470E-17
2500	.2011E 01	.1000E 01	.00002	.84291E-02	-.75428E-14
3000	.2035E 01	.1000E 01	.00007	.20320E-02	-.64606E-12
3500	.2077E 01	.1001E 01	.00019	.74798E-03	-.15112E-10
4000	.2141E 01	.1005E 01	.00039	.36582E-03	-.14764E-09
4500	.2225E 01	.1012E 01	.00063	.22671E-03	-.67969E-09
5000	.2329E 01	.1024E 01	.00077	.18606E-03	-.14027E-08
5500	.2449E 01	.1045E 01	.00078	.18571E-03	-.15517E-08
6000	.2583E 01	.1074E 01	.00073	.19849E-03	-.13863E-08
6500	.2731E 01	.1113E 01	.00067	.21410E-03	-.11968E-08
7000	.2890E 01	.1163E 01	.00063	.23031E-03	-.10353E-08
7500	.3061E 01	.1224E 01	.00058	.24668E-03	-.90277E-09
8000	.3244E 01	.1297E 01	.00055	.26310E-03	-.79371E-09
8500	.3439E 01	.1379E 01	.00052	.27953E-03	-.70317E-09
9000	.3648E 01	.1473E 01	.00049	.29597E-03	-.62724E-09
9500	.3873E 01	.1575E 01	.00046	.31241E-03	-.56296E-09
10000	.4115E 01	.1687E 01	.00044	.32885E-03	-.50808E-09

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 18	.1101E 18	.1101E 14	.8973E 07	.1993E-17
2500	.6808E 17	.8807E 17	.8807E 13	.8378E 09	.2715E-13
3000	.7340E 17	.7339E 17	.7323E 13	.1730E 11	.1670E-10
3500	.6291E 17	.6291E 17	.6142E 13	.1490E 12	.1722E-08
4000	.5505E 17	.5504E 17	.4793E 13	.7117E 12	.5759E-07
4500	.4893E 17	.4893E 17	.2845E 13	.2048E 13	.9044E-06
5000	.4404E 17	.4403E 17	.9645E 12	.3439E 13	.8353E-05
5500	.4004E 17	.4003E 17	.2059E 12	.3797E 13	.5247E-04
6000	.3670E 17	.3669E 17	.4348E 11	.3626E 13	.2472E-03
6500	.3388E 17	.3387E 17	.1080E 11	.3377E 13	.9345E-03
7000	.3146E 17	.3145E 17	.3166E 10	.3142E 13	.2974E-02
7500	.2936E 17	.2935E 17	.1067E 10	.2935E 13	.8248E-02
8000	.2753E 17	.2752E 17	.4038E 09	.2752E 13	.2044E-01
8500	.2591E 17	.2590E 17	.1684E 09	.2590E 13	.4615E-01
9000	.2447E 17	.2446E 17	.7628E 08	.2446E 13	.9625E-01
9500	.2318E 17	.2317E 17	.3710E 08	.2318E 13	.1876E 00
10000	.2202E 17	.2202E 17	.1921E 08	.2202E 13	.3446E 00

PRESSURE= .03 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-09	.1985E-13
2500	.1397E-07	.2084E-10
3000	.2200E-06	.2060E-08
3500	.1490E-05	.5182E-07
4000	.5487E-05	.5106E-06
4500	.1072E-04	.2145E-05
5000	.9296E-05	.3431E-05
5500	.4223E-05	.2572E-05
6000	.1654E-05	.1529E-05
6500	.6858E-06	.9028E-06
7000	.3090E-06	.5506E-06
7500	.1499E-06	.3472E-06
8000	.7743E-07	.2257E-06
8500	.4218E-07	.1506E-06
9000	.2406E-07	.1028E-06
9500	.1428E-07	.7171E-07
10000	.8786E-08	.5100E-07

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.55354E-01	-.21307E-16
2500	.2011E 01	.1000E 01	.00002	.64047E-02	-.17195E-13
3000	.2035E 01	.1000E 01	.00009	.15436E-02	-.14739E-11
3500	.2077E 01	.1001E 01	.00025	.56688E-03	-.34717E-10
4000	.2141E 01	.1005E 01	.00053	.27390E-03	-.35173E-09
4500	.2225E 01	.1012E 01	.00088	.16418E-03	-.18372E-08
5000	.2329E 01	.1024E 01	.00118	.12201E-03	-.49747E-08
5500	.2449E 01	.1045E 01	.00129	.11195E-03	-.70839E-08
6000	.2583E 01	.1074E 01	.00124	.11591E-03	-.69615E-08
6500	.2731E 01	.1113E 01	.00116	.12401E-03	-.61587E-08
7000	.2890E 01	.1163E 01	.00108	.13312E-03	-.53621E-08
7500	.3061E 01	.1224E 01	.00101	.14249E-03	-.46844E-08
8000	.3244E 01	.1297E 01	.00095	.15194E-03	-.41212E-08
8500	.3439E 01	.1379E 01	.00089	.16142E-03	-.36520E-08
9000	.3648E 01	.1473E 01	.00084	.17090E-03	-.32579E-08
9500	.3873E 01	.1575E 01	.00080	.18039E-03	-.29242E-08
10000	.4115E 01	.1687E 01	.00076	.18988E-03	-.26392E-08

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 18	.1101E 18	.3303E 14	.1554E 08	.1993E-17
2500	.8808E 17	.8605E 17	.2642E 14	.1451E 10	.2715E-13
3000	.7340E 17	.7338E 17	.2199E 14	.2998E 11	.1671E-10
3500	.6291E 17	.6290E 17	.1851E 14	.2593E 12	.1723E-08
4000	.5505E 17	.5503E 17	.1525E 14	.1270E 13	.5761E-07
4500	.4893E 17	.4891E 17	.1070E 14	.3975E 13	.9049E-06
5000	.4404E 17	.4402E 17	.5212E 13	.7998E 13	.8361E-05
5500	.4004E 17	.4001E 17	.1558E 13	.1045E 14	.5253E-04
6000	.3670E 17	.3668E 17	.3735E 12	.1063E 14	.2474E-03
6500	.3388E 17	.3386E 17	.9585E 11	.1006E 14	.9353E-03
7000	.3146E 17	.3144E 17	.2835E 11	.9406E 13	.2976E-02
7500	.2936E 17	.2934E 17	.9578E 10	.8796E 13	.8254E-02
8000	.2753E 17	.2751E 17	.3628E 10	.8251E 13	.2046E-01
8500	.2591E 17	.2589E 17	.1514E 10	.7768E 13	.4617E-01
9000	.2447E 17	.2445E 17	.6856E 09	.7337E 13	.9629E-01
9500	.2319E 17	.2317E 17	.3334E 09	.6951E 13	.1876E 00
10000	.2202E 17	.2201E 17	.1725E 09	.6604E 13	.3447E 00

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-09	.5954E-13
2500	.4192E-07	.6253E-10
3000	.6608E-06	.6188E-08
3500	.4515E-05	.1570E-06
4000	.1745E-04	.1624E-05
4500	.4035E-04	.8071E-05
5000	.5023E-04	.1854E-04
5500	.3195E-04	.1946E-04
6000	.1420E-04	.1313E-04
6500	.6084E-05	.8010E-05
7000	.2766E-05	.4929E-05
7500	.1345E-05	.3117E-05
8000	.6957E-06	.2028E-05
8500	.3791E-06	.1353E-05
9000	.2162E-06	.9741E-06
9500	.1283E-06	.6444E-06
10000	.7870E-07	.4580E-06

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.40967E-01	-.52563E-16
2500	.2011E 01	.1000E 01	.00003	.47399E-02	-.42420E-13
3000	.2035E 01	.1000E 01	.00013	.11422E-02	-.36380E-11
3500	.2077E 01	.1001E 01	.00034	.41885E-03	-.86066E-10
4000	.2141E 01	.1005E 01	.00072	.20086E-03	-.89191E-09
4500	.2225E 01	.1012E 01	.00123	.11724E-03	-.50456E-08
5000	.2329E 01	.1024E 01	.00177	.81523E-04	-.16675E-07
5500	.2449E 01	.1045E 01	.00212	.67825E-04	-.31851E-07
6000	.2583E 01	.1074E 01	.00219	.65735E-04	-.38168E-07
6500	.2731E 01	.1113E 01	.00210	.68665E-04	-.36278E-07
7000	.2890E 01	.1163E 01	.00197	.73189E-04	-.32263E-07
7500	.3061E 01	.1224E 01	.00184	.78170E-04	-.28372E-07
8000	.3244E 01	.1297E 01	.00173	.83292E-04	-.25016E-07
8500	.3439E 01	.1379E 01	.00163	.88462E-04	-.22187E-07
9000	.3648E 01	.1473E 01	.00154	.93650E-04	-.19800E-07
9500	.3873E 01	.1575E 01	.00146	.98845E-04	-.17775E-07
10000	.4115E 01	.1687E 01	.00138	.10404E-03	-.16043E-07

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 18	.1100E 18	.1101E 15	.2838E 08	.1993E-17
2500	.8808E 17	.8799E 17	.8808E 14	.2650E 10	.2715E-13
3000	.7340E 17	.7333E 17	.7335E 14	.5476E 11	.1671E-10
3500	.6291E 17	.6285E 17	.6244E 14	.4750E 12	.1723E-08
4000	.5505E 17	.5499E 17	.5269E 14	.2361E 13	.5764E-07
4500	.4893E 17	.4888E 17	.4113E 14	.7795E 13	.9058E-06
5000	.4404E 17	.4398E 17	.2611E 14	.1791E 14	.8372E-05
5500	.4004E 17	.3997E 17	.1154E 14	.2847E 14	.5262E-04
6000	.3670E 17	.3663E 17	.3605E 13	.3306E 14	.2479E-03
6500	.3388E 17	.3381E 17	.1018E 13	.3283E 14	.9369E-03
7000	.3146E 17	.3139E 17	.3098E 12	.3112E 14	.2981E-02
7500	.2936E 17	.2930E 17	.1056E 12	.2923E 14	.8264E-02
8000	.2753E 17	.2747E 17	.4013E 11	.2746E 14	.2048E-01
8500	.2591E 17	.2585E 17	.1676E 11	.2586E 14	.4622E-01
9000	.2447E 17	.2442E 17	.7597E 10	.2443E 14	.9638E-01
9500	.2318E 17	.2313E 17	.3695E 10	.2315E 14	.1878E 00
10000	.2202E 17	.2198E 17	.1911E 10	.2200E 14	.3450E 00

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	SPECTRAL LINE INTENSITIES,WATTS/(CC STER) LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-08	.1985E-12
2500	.1397E-06	.2084E-09
3000	.2294E-05	.2064E-07
3500	.1515E-04	.5268E-06
4000	.6031E-04	.5612E-05
4500	.1550E-03	.3101E-04
5000	.2516E-03	.9286E-04
5500	.2367E-03	.1441E-03
6000	.1371E-03	.1267E-03
6500	.6465E-04	.8511E-04
7000	.3023E-04	.5387E-04
7500	.1493E-04	.3437E-04
8000	.7694E-05	.2243E-04
8500	.4198E-05	.1498E-04
9000	.2396E-05	.1024E-04
9500	.1422E-05	.7142E-05
10000	.8744E-06	.5075E-05

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.31128E-01	-.11982E-15
2500	.2011E 01	.1000E 01	.00004	.36015E-02	-.96701E-13
3000	.2035E 01	.1000E 01	.00017	.86776E-03	-.82958E-11
3500	.2077E 01	.1001E 01	.00045	.31798E-03	-.19671E-09
4000	.2141E 01	.1005E 01	.00095	.15189E-03	-.20625E-08
4500	.2225E 01	.1012E 01	.00165	.87448E-04	-.12159E-07
5000	.2329E 01	.1024E 01	.00246	.58637E-04	-.44811E-07
5500	.2449E 01	.1045E 01	.00316	.45525E-04	-.10533E-06
6000	.2583E 01	.1074E 01	.00353	.40831E-04	-.15926E-06
6500	.2731E 01	.1113E 01	.00353	.40758E-04	-.17347E-06
7000	.2890E 01	.1163E 01	.00337	.42697E-04	-.16250E-06
7500	.3061E 01	.1224E 01	.00318	.45335E-04	-.14544E-06
8000	.3244E 01	.1297E 01	.00299	.48206E-04	-.12904E-06
8500	.3439E 01	.1379E 01	.00281	.51157E-04	-.11472E-06
9000	.3648E 01	.1473E 01	.00266	.54139E-04	-.10248E-06
9500	.3873E 01	.1575E 01	.00252	.57134E-04	-.92040E-07
10000	.4115E 01	.1687E 01	.00239	.60135E-04	-.83093E-07

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 18	.1098E 18	.3303E 15	.4915E 08	.1993E-17
2500	.8808E 17	.8782E 17	.2642E 15	.4589E 10	.2715E-13
3000	.7340E 17	.7318E 17	.2201E 15	.9486E 11	.1671E-10
3500	.6291E 17	.6272E 17	.1879E 15	.8242E 12	.1724E-08
4000	.5505E 17	.5488E 17	.1610E 15	.4128E 13	.5768E-07
4500	.4893E 17	.4877E 17	.1327E 15	.1401E 14	.9067E-06
5000	.4404E 17	.4387E 17	.9739E 14	.3463E 14	.8386E-05
5500	.4004E 17	.3985E 17	.5673E 14	.6319E 14	.5274E-04
6000	.3670E 17	.3650E 17	.2415E 14	.8569E 14	.2485E-03
6500	.3388E 17	.3368E 17	.8184E 13	.9317E 14	.9393E-03
7000	.3146E 17	.3127E 17	.2668E 13	.9143E 14	.2988E-02
7500	.2936E 17	.2919E 17	.9315E 12	.8689E 14	.8281E-02
8000	.2753E 17	.2736E 17	.3569E 12	.8197E 14	.2052E-01
8500	.2591E 17	.2575E 17	.1496E 12	.7734E 14	.4629E-01
9000	.2447E 17	.2432E 17	.6771E 11	.7311E 14	.9652E-01
9500	.2318E 17	.2304E 17	.3305E 11	.6930E 14	.1880E 00
10000	.2202E 17	.2189E 17	.1710E 11	.6585E 14	.3454E 00

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	SPECTRAL LINE INTENSITIES,WATTS/(CC STER) LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-08	.5954E-12
2500	.4192E-06	.6253E-09
3000	.6614E-05	.6193E-07
3500	.4558E-04	.1585E-05
4000	.1843E-03	.1715E-04
4500	.5003E-03	.1001E-03
5000	.9387E-03	.3464E-03
5500	.1163E-02	.7086E-03
6000	.9185E-03	.8493E-03
6500	.5195E-03	.6839E-03
7000	.2604E-03	.4640E-03
7500	.1309E-03	.3032E-03
8000	.6844E-04	.1995E-03
8500	.3747E-04	.1338E-03
9000	.2142E-04	.9153E-04
9500	.1272E-04	.6388E-04
10000	.7824E-05	.4542E-04

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.23037E-01	-.29558E-15
2500	.2011E 01	.1000E 01	.00005	.26654E-02	-.23857E-12
3000	.2035E 01	.1000E 01	.00022	.64215E-03	-.20472E-10
3500	.2077E 01	.1001E 01	.00061	.23516E-03	-.48619E-09
4000	.2141E 01	.1005E 01	.00128	.11207E-03	-.51355E-08
4500	.2225E 01	.1012E 01	.00225	.63968E-04	-.31064E-07
5000	.2329E 01	.1024E 01	.00343	.41921E-04	-.12264E-06
5500	.2449E 01	.1045E 01	.00464	.31007E-04	-.33336E-06
6000	.2583E 01	.1074E 01	.00558	.25817E-04	-.63007E-06
6500	.2731E 01	.1113E 01	.00600	.24011E-04	-.84844E-06
7000	.2890E 01	.1163E 01	.00596	.24151E-04	-.89795E-06
7500	.3061E 01	.1224E 01	.00571	.25206E-04	-.84627E-06
8000	.3244E 01	.1297E 01	.00541	.26623E-04	-.76603E-06
8500	.3439E 01	.1379E 01	.00511	.28178E-04	-.68645E-06
9000	.3648E 01	.1473E 01	.00483	.29788E-04	-.61529E-06
9500	.3873E 01	.1575E 01	.00458	.31419E-04	-.55344E-06
10000	.4115E 01	.1687E 01	.00436	.33061E-04	-.50001E-06

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 18	.1090E 18	.1101E 16	.8973E 08	.1993E-17
2500	.8808E 17	.8720E 17	.8808E 15	.8379E 10	.2715E-13
3000	.7340E 17	.7267E 17	.7338E 15	.1732E 12	.1671E-10
3500	.6291E 17	.6228E 17	.6276E 15	.1507E 13	.1725E-08
4000	.5505E 17	.5449E 17	.5428E 15	.7584E 13	.5774E-07
4500	.4893E 17	.4842E 17	.4629E 15	.2619E 14	.9081E-06
5000	.4404E 17	.4353E 17	.3720E 15	.6775E 14	.8405E-05
5500	.4004E 17	.3950E 17	.2628E 15	.1362E 15	.5290E-04
6000	.3670E 17	.3612E 17	.1505E 15	.2144E 15	.2495E-03
6500	.3388E 17	.3327E 17	.6764E 14	.2685E 15	.9435E-03
7000	.3146E 17	.3086E 17	.2595E 14	.2858E 15	.3001E-02
7500	.2936E 17	.2879E 17	.9710E 13	.2811E 15	.8314E-02
8000	.2753E 17	.2698E 17	.3823E 13	.2687E 15	.2059E-01
8500	.2591E 17	.2540E 17	.1620E 13	.2549E 15	.4644E-01
9000	.2447E 17	.2398E 17	.7389E 12	.2415E 15	.9679E-01
9500	.2318E 17	.2272E 17	.3605E 12	.2291E 15	.1885E 00
10000	.2202E 17	.2158E 17	.1868E 12	.2178E 15	.3462E 00

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-07	.1985E-11
2500	.1397E-05	.2085E-08
3000	.2205E-04	.2065E-06
3500	.1522E-03	.5295E-05
4000	.6214E-03	.5783E-04
4500	.1745E-02	.3490E-03
5000	.3585E-02	.1323E-02
5500	.5369E-02	.3282E-02
6000	.5724E-02	.5293E-02
6500	.4294E-02	.5652E-02
7000	.2533E-02	.4513E-02
7500	.1364E-02	.3160E-02
8000	.7331E-03	.2137E-02
8500	.4057E-03	.1448E-02
9000	.2330E-03	.9959E-03
9500	.1388E-03	.6967E-03
10000	.8544E-04	.4959E-03

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.17504E-01	-.67379E-15
2500	.2011E 01	.1000E 01	.00007	.20252E-02	-.54386E-12
3000	.2035E 01	.1000E 01	.00030	.48788E-03	-.46679E-10
3500	.2077E 01	.1001E 01	.00081	.17863E-03	-.11096E-08
4000	.2141E 01	.1005E 01	.00169	.85004E-04	-.11768E-07
4500	.2225E 01	.1012E 01	.00298	.48306E-04	-.72135E-07
5000	.2329E 01	.1024E 01	.00460	.31285E-04	-.29505E-06
5500	.2449E 01	.1045E 01	.00638	.22551E-04	-.86660E-06
6000	.2583E 01	.1074E 01	.00803	.17933E-04	-.18800E-05
6500	.2731E 01	.1113E 01	.00918	.15690E-04	-.30407E-05
7000	.2890E 01	.1163E 01	.00963	.14950E-04	-.37857E-05
7500	.3061E 01	.1224E 01	.00953	.15106E-04	-.39316E-05
8000	.3244E 01	.1297E 01	.00916	.15714E-04	-.37251E-05
8500	.3439E 01	.1379E 01	.00871	.16522E-04	-.34051E-05
9000	.3648E 01	.1473E 01	.00827	.17415E-04	-.30789E-05
9500	.3873E 01	.1575E 01	.00785	.18345E-04	-.27806E-05
10000	.4115E 01	.1687E 01	.00746	.19291E-04	-.25171E-05

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 18	.1068E 18	.3303E 16	.1554E 09	.1993E-17
2500	.6808E 17	.8544E 17	.2642E 16	.1451E 11	.2715E-13
3000	.7340E 17	.7120E 17	.2202E 16	.3001E 12	.1672E-10
3500	.6291E 17	.6102E 17	.1885E 16	.2612E 13	.1726E-08
4000	.5505E 17	.5339E 17	.1638E 16	.1318E 14	.5781E-07
4500	.4893E 17	.4742E 17	.1421E 16	.4592E 14	.9099E-06
5000	.4404E 17	.4260E 17	.1196E 16	.1216E 15	.8428E-05
5500	.4004E 17	.3859E 17	.9359E 15	.2575E 15	.5310E-04
6000	.3670E 17	.3517E 17	.6435E 15	.4443E 15	.2507E-03
6500	.3388E 17	.3225E 17	.3689E 15	.6287E 15	.9488E-03
7000	.3146E 17	.2979E 17	.1757E 15	.7458E 15	.3019E-02
7500	.2936E 17	.2772E 17	.7482E 14	.7826E 15	.8363E-02
8000	.2753E 17	.2595E 17	.3133E 14	.7714E 15	.2070E-01
8500	.2591E 17	.2441E 17	.1364E 14	.7414E 15	.4667E-01
9000	.2447E 17	.2305E 17	.6294E 13	.7066E 15	.9722E-01
9500	.2318E 17	.2183E 17	.3089E 13	.6722E 15	.1893E 00
10000	.2202E 17	.2074E 17	.1605E 13	.6399E 15	.3474E 00

PRESSURE= .03 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-07	.5954E-11
2500	.4192E-05	.6254E-08
3000	.6616E-04	.6195E-06
3500	.4572E-03	.1590E-04
4000	.1875E-02	.1745E-03
4500	.5355E-02	.1071E-02
5000	.1153E-01	.4254E-02
5500	.1919E-01	.1169E-01
6000	.2447E-01	.2263E-01
6500	.2341E-01	.3082E-01
7000	.1714E-01	.3055E-01
7500	.1051E-01	.2435E-01
8000	.6007E-02	.1751E-01
8500	.3416E-02	.1219E-01
9000	.1985E-02	.8483E-02
9500	.1189E-02	.5971E-02
10000	.7344E-03	.4263E-02

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP DEG K	INTERNAL PARTITION FUNCTION CUI	CUII	IONIZATION POTENTIAL LOWERING FOR CUI,EV	DEBYE RADIUS,CM	DEBYE PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.53915E-01	-.23059E-16
2500	.2011E 01	.1000E 01	.00002	.62381E-02	-.18609E-13
3000	.2035E 01	.1000E 01	.00010	.15034E-02	-.15952E-11
3500	.2077E 01	.1001E 01	.00026	.55204E-03	-.37592E-10
4000	.2141E 01	.1005E 01	.00054	.26651E-03	-.38184E-09
4500	.2225E 01	.1012E 01	.00090	.15927E-03	-.20126E-08
5000	.2329E 01	.1024E 01	.00123	.11751E-03	-.55685E-08
5500	.2449E 01	.1045E 01	.00135	.10686E-03	-.81442E-08
6000	.2583E 01	.1074E 01	.00131	.11015E-03	-.81115E-08
6500	.2731E 01	.1113E 01	.00122	.11770E-03	-.72040E-08
7000	.2890E 01	.1163E 01	.00114	.12629E-03	-.62789E-08
7500	.3061E 01	.1224E 01	.00107	.13517E-03	-.54871E-08
8000	.3244E 01	.1297E 01	.00100	.14413E-03	-.48279E-08
8500	.3439E 01	.1379E 01	.00094	.15312E-03	-.42784E-08
9000	.3648E 01	.1473E 01	.00089	.16212E-03	-.38168E-08
9500	.3873E 01	.1575E 01	.00084	.17112E-03	-.34259E-08
10000	.4115E 01	.1687E 01	.00080	.18012E-03	-.30920E-08

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 18	.3670E 18	.3670E 14	.1638E 08	.1993E-17
2500	.2936E 18	.2936E 18	.2936E 14	.1530E 10	.2715E-13
3000	.2447E 18	.2446E 18	.2444E 14	.3160E 11	.1671E-10
3500	.2097E 18	.2097E 18	.2070E 14	.2735E 12	.1723E-08
4000	.1835E 18	.1835E 18	.1701E 14	.1341E 13	.5762E-07
4500	.1631E 18	.1631E 18	.1209E 14	.4224E 13	.9050E-06
5000	.1468E 18	.1468E 18	.6057E 13	.8623E 13	.8362E-05
5500	.1335E 18	.1334E 18	.1876E 13	.1147E 14	.5254E-04
6000	.1223E 18	.1223E 18	.4579E 12	.1177E 14	.2475E-03
6500	.1129E 18	.1129E 18	.1182E 12	.1117E 14	.9355E-03
7000	.1049E 18	.1048E 18	.3498E 11	.1045E 14	.2977E-02
7500	.9787E 17	.9785E 17	.1183E 11	.9774E 13	.8254E-02
8000	.9175E 17	.9173E 17	.4480E 10	.9170E 13	.2046E-01
8500	.8635E 17	.8634E 17	.1869E 10	.8633E 13	.4617E-01
9000	.8156E 17	.8154E 17	.8468E 09	.8154E 13	.9630E-01
9500	.7726E 17	.7725E 17	.4119E 09	.7725E 13	.1877E 00
10000	.7340E 17	.7339E 17	.2130E 09	.7339E 13	.3447E 00

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-09	.6615E-13
2500	.4658E-07	.6948E-10
3000	.7342E-06	.6876E-08
3500	.5021E-05	.1746E-06
4000	.1947E-04	.1812E-05
4500	.4556E-04	.9114E-05
5000	.5837E-04	.2154E-04
5500	.3847E-04	.2343E-04
6000	.1741E-04	.1610E-04
6500	.7502E-05	.9876E-05
7000	.3414E-05	.6083E-05
7500	.1661E-05	.3849E-05
8000	.8590E-06	.2504E-05
8500	.4682E-06	.1671E-05
9000	.2671E-06	.1141E-05
9500	.1585E-06	.7960E-06
10000	.9741E-07	.5655E-06

PRESSURE= .10 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP DEG K	INTERNAL PARTITION FUNCTION CUI	CUII	IONIZATION POTENTIAL LOWERING FOR CUI,EV	DEBYE RADIUS,CM	DEBYE PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.40967E-01	-.52563E-16
2500	.2011E 01	.1000E 01	.00003	.47399E-02	-.42420E-13
3000	.2035E 01	.1000E 01	.00013	.11422E-02	-.36380E-11
3500	.2077E 01	.1001E 01	.00034	.41885E-03	-.86066E-10
4000	.2141E 01	.1005E 01	.00072	.20086E-03	-.89193E-09
4500	.2225E 01	.1012E 01	.00123	.11724E-03	-.50461E-08
5000	.2329E 01	.1024E 01	.00177	.81516E-04	-.16679E-07
5500	.2449E 01	.1045E 01	.00212	.67812E-04	-.31870E-07
6000	.2583E 01	.1074E 01	.00219	.65716E-04	-.38201E-07
6500	.2731E 01	.1113E 01	.00210	.68643E-04	-.36314E-07
7000	.2890E 01	.1163E 01	.00197	.73164E-04	-.32297E-07
7500	.3061E 01	.1224E 01	.00184	.78143E-04	-.28401E-07
8000	.3244E 01	.1297E 01	.00173	.83263E-04	-.25042E-07
8500	.3439E 01	.1379E 01	.00163	.88431E-04	-.22210E-07
9000	.3648E 01	.1473E 01	.00154	.93617E-04	-.19821E-07
9500	.3873E 01	.1575E 01	.00146	.98810E-04	-.17793E-07
10000	.4115E 01	.1637E 01	.00138	.10401E-03	-.16060E-07

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 18	.3669E 18	.1101E 15	.2838E 08	.1993E-17
2500	.2936E 18	.2935E 18	.8808E 14	.2650E 10	.2715E-13
3000	.2447E 18	.2446E 18	.7335E 14	.5476E 11	.1671E-10
3500	.2097E 18	.2097E 18	.6244E 14	.4750E 12	.1723E-08
4000	.1835E 18	.1834E 18	.5269E 14	.2361E 13	.5764E-07
4500	.1631E 18	.1631E 18	.4114E 14	.7796E 13	.9058E-06
5000	.1468E 18	.1467E 18	.2612E 14	.1792E 14	.8372E-05
5500	.1335E 18	.1334E 18	.1155E 14	.2848E 14	.5262E-04
6000	.1223E 18	.1223E 18	.3609E 13	.3308E 14	.2479E-03
6500	.1129E 18	.1129E 18	.1020E 13	.3285E 14	.9369E-03
7000	.1049E 18	.1048E 18	.3102E 12	.3114E 14	.2981E-02
7500	.9787E 17	.9781E 17	.1057E 12	.2925E 14	.8264E-02
8000	.9175E 17	.9170E 17	.4018E 11	.2748E 14	.2048E-01
8500	.8635E 17	.8630E 17	.1678E 11	.2588E 14	.4622E-01
9000	.8156E 17	.8151E 17	.7607E 10	.2445E 14	.9638E-01
9500	.7726E 17	.7722E 17	.3700E 10	.2317E 14	.1878E 00
10000	.7340E 17	.7336E 17	.1914E 10	.2201E 14	.3450E 00

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	SPECTRAL LINE INTENSITIES, WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-08	.1985E-12
2500	.1397E-06	.2084E-09
3000	.2204E-05	.2064E-07
3500	.1515E-04	.5268E-06
4000	.6032E-04	.5613E-05
4500	.1550E-03	.3102E-04
5000	.2517E-03	.9290E-04
5500	.2368E-03	.1442E-03
6000	.1372E-03	.1269E-03
6500	.6474E-04	.8522E-04
7000	.3027E-04	.5394E-04
7500	.1485E-04	.3441E-04
8000	.7705E-05	.2246E-04
8500	.4204E-05	.1501E-04
9000	.2399E-05	.1025E-04
9500	.1424E-05	.7151E-05
10000	.8756E-06	.5082E-05

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.30319E-01	-.12967E-15
2500	.2011E 01	.1000E 01	.00004	.35079E-02	-.10465E-12
3000	.2035E 01	.1000E 01	.00017	.84520E-03	-.89782E-11
3500	.2077E 01	.1001E 01	.00046	.30969E-03	-.21293E-09
4000	.2141E 01	.1005E 01	.00097	.14789E-03	-.22345E-08
4500	.2225E 01	.1012E 01	.00169	.85058E-04	-.13213E-07
5000	.2329E 01	.1024E 01	.00253	.56881E-04	-.49091E-07
5500	.2449E 01	.1045E 01	.00328	.43918E-04	-.11732E-06
6000	.2583E 01	.1074E 01	.00368	.39090E-04	-.18151E-06
6500	.2731E 01	.1113E 01	.00371	.38792E-04	-.20120E-06
7000	.2890E 01	.1163E 01	.00355	.40529E-04	-.18999E-06
7500	.3061E 01	.1224E 01	.00335	.42992E-04	-.17054E-06
8000	.3244E 01	.1297E 01	.00315	.45698E-04	-.15148E-06
8500	.3439E 01	.1379E 01	.00297	.48489E-04	-.13472E-06
9000	.3648E 01	.1473E 01	.00281	.51313E-04	-.12037E-06
9500	.3873E 01	.1575E 01	.00266	.54150E-04	-.10811E-06
10000	.4115E 01	.1687E 01	.00253	.56993E-04	-.97607E-07

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 18	.3666E 18	.3670E 15	.5181E 06	.1993E-17
2500	.2936E 18	.2933E 18	.2936E 15	.4838E 10	.2715E-13
3000	.2447E 18	.2444E 18	.2446E 15	1.0000E 11	.1671E-10
3500	.2097E 18	.2095E 18	.2088E 15	.8690E 12	.1724E-08
4000	.1835E 18	.1833E 18	.1791E 15	.4355E 13	.5769E-07
4500	.1631E 18	.1629E 18	.1483E 15	.1481E 14	.9068E-06
5000	.1468E 18	.1466E 18	.1100E 15	.3680E 14	.8387E-05
5500	.1335E 18	.1333E 18	.6549E 14	.6790E 14	.5275E-04
6000	.1223E 18	.1221E 18	.2874E 14	.9350E 14	.2486E-03
6500	.1129E 18	.1127E 18	.9970E 13	.1029E 15	.9396E-03
7000	.1049E 18	.1047E 18	.3286E 13	.1015E 15	.2989E-02
7500	.9787E 17	.9767E 17	.1152E 13	.9662E 14	.8284E-02
8000	.9175E 17	.9157E 17	.4419E 12	.9122E 14	.2052E-01
8500	.8635E 17	.8618E 17	.1853E 12	.8608E 14	.4630E-01
9000	.8156E 17	.8139E 17	.8414E 11	.8139E 14	.9654E-01
9500	.7726E 17	.7711E 17	.4096E 11	.7715E 14	.1881E 00
10000	.7342E 17	.7325E 17	.2120E 11	.7331E 14	.3454E 00

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-08	.6615E-12
2500	.4658E-06	.6948E-09
3000	.7349E-05	.6882E-07
3500	.5066E-04	.1762E-05
4000	.2051E-03	.1908E-04
4500	.5589E-03	.1118E-03
5000	.1060E-02	.3911E-03
5500	.1343E-02	.8180E-03
6000	.1093E-02	.1011E-02
6500	.6328E-03	.8331E-03
7000	.3206E-03	.5713E-03
7500	.1618E-03	.3748E-03
8000	.8473E-04	.2470E-03
8500	.4642E-04	.1657E-03
9000	.2654E-04	.1134E-03
9500	.1577E-04	.7916E-04
10000	.9696E-05	.5628E-04

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.23037E-01	-.29558E-15
2500	.2011E 01	.1000E 01	.00005	.26654E-02	-.23857E-12
3000	.2035E 01	.1000E 01	.00022	.64215E-03	-.20472E-10
3500	.2077E 01	.1001E 01	.00061	.23518E-03	-.48619E-09
4000	.2141E 01	.1005E 01	.00128	.11206E-03	-.51359E-08
4500	.2225E 01	.1012E 01	.00225	.63962E-04	-.31073E-07
5000	.2329E 01	.1024E 01	.00344	.41908E-04	-.12275E-06
5500	.2449E 01	.1045E 01	.00465	.30985E-04	-.33408E-06
6000	.2583E 01	.1074E 01	.00559	.25779E-04	-.63281E-06
6500	.2731E 01	.1113E 01	.00601	.23956E-04	-.85433E-06
7000	.2890E 01	.1163E 01	.00598	.24080E-04	-.90589E-06
7500	.3061E 01	.1224E 01	.00573	.25124E-04	-.85454E-06
8000	.3244E 01	.1297E 01	.00543	.26534E-04	-.77382E-06
8500	.3439E 01	.1379E 01	.00513	.78082E-04	-.59355E-06
9000	.3648E 01	.1473E 01	.00485	.29685E-04	-.62169E-06
9500	.3873E 01	.1575E 01	.00460	.31311E-04	-.55922E-06
10000	.4115E 01	.1687E 01	.00437	.32947E-04	-.50524E-06

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 18	.3659E 18	.1101E 16	.8973E 08	.1993E-17
2500	.2936E 18	.2927E 18	.8808E 15	.8379E 10	.2715E-13
3000	.2447E 18	.2439E 18	.7338E 15	.1732E 12	.1671E-10
3500	.2097E 18	.2091E 18	.6276E 15	.1507E 13	.1725E-08
4000	.1835E 18	.1829E 18	.5429E 15	.7584E 13	.5774E-07
4500	.1631E 18	.1626E 18	.4631E 15	.2619E 14	.9082E-06
5000	.1468E 18	.1463E 18	.3724E 15	.6779E 14	.8405E-05
5500	.1335E 18	.1329E 18	.2635E 15	.1364E 15	.5290E-04
6000	.1223E 18	.1218E 18	.1514E 15	.2150E 15	.2495E-03
6500	.1129E 18	.1123E 18	.6827E 14	.2697E 15	.9435E-03
7000	.1049E 18	.1043E 18	.2626E 14	.2875E 15	.3001E-02
7500	.9787E 17	.9729E 17	.9837E 13	.2829E 15	.8314E-02
8000	.9175E 17	.9121E 17	.3875E 13	.2706E 15	.2059E-01
8500	.8635E 17	.8584E 17	.1642E 13	.2566E 15	.4644E-01
9000	.8156E 17	.8107E 17	.7492E 12	.2432E 15	.9679E-01
9500	.7726E 17	.7680E 17	.3655E 12	.2307E 15	.1885E 00
10000	.7340E 17	.7296E 17	.1894E 12	.2194E 15	.3462E 00

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-07	.1985E-11
2500	.1337E-05	.2085E-08
3000	.2205E-04	.2065E-06
3500	.1522E-03	.5295E-05
4000	.6215E-03	.5783E-04
4500	.1745E-02	.3492E-03
5000	.3589E-02	.1325E-02
5500	.5405E-02	.3292E-02
6000	.5757E-02	.5323E-02
6500	.4334E-02	.5705E-02
7000	.2563E-02	.4567E-02
7500	.1382E-02	.3201E-02
8000	.7431E-03	.2166E-02
8500	.4113E-03	.1468E-02
9000	.2363E-03	.1010E-02
9500	.1407E-03	.7064E-03
10000	.8663E-04	.5028E-03

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.17049E-01	-.72920E-15
2500	.2011E 01	.1000E 01	.00007	.19725E-02	-.58858E-12
3000	.2035E 01	.1000E 01	.00030	.47519E-03	-.50518E-10
3500	.2077E 01	.1001E 01	.00083	.17397E-03	-.12010E-08
4000	.2141E 01	.1005E 01	.00174	.82779E-04	-.12742E-07
4500	.2225E 01	.1012E 01	.00306	.47021E-04	-.78212E-07
5000	.2329E 01	.1024E 01	.00473	.30417E-04	-.32105E-06
5500	.2449E 01	.1045E 01	.00658	.21868E-04	-.95036E-06
6000	.2583E 01	.1074E 01	.00832	.17306E-04	-.20919E-05
6500	.2731E 01	.1113E 01	.00958	.15032E-04	-.34576E-05
7000	.2690E 01	.1163E 01	.01013	.14211E-04	-.44075E-05
7500	.3061E 01	.1224E 01	.01009	.14276E-04	-.46577E-05
8000	.3244E 01	.1297E 01	.00973	.14805E-04	-.44550E-05
8500	.3439E 01	.1379E 01	.00926	.15543E-04	-.40904E-05
9000	.3648E 01	.1473E 01	.00879	.16372E-04	-.37060E-05
9500	.3873E 01	.1575E 01	.00835	.17240E-04	-.33502E-05
10000	.4115E 01	.1687E 01	.00794	.18126E-04	-.30341E-05

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 18	.3633E 18	.3670E 16	.1638E 09	.1993E-17
2500	.2936E 18	.2907E 18	.2936E 16	.1530E 11	.2715E-13
3000	.2447E 18	.2422E 18	.2446E 16	.3163E 12	.1672E-10
3500	.2097E 18	.2076E 18	.2094E 16	.2753E 13	.1726E-08
4000	.1835E 18	.1817E 18	.1821E 16	.1390E 14	.5782E-07
4500	.1631E 18	.1614E 18	.1582E 16	.4846E 14	.9101E-06
5000	.1468E 18	.1452E 18	.1338E 16	.1287E 15	.8430E-05
5500	.1335E 18	.1319E 18	.1058E 16	.2739E 15	.5312E-04
6000	.1223E 18	.1206E 18	.7415E 15	.4770E 15	.2509E-03
6500	.1129E 18	.1111E 18	.4375E 15	.6849E 15	.9495E-03
7000	.1049E 18	.1030E 18	.2150E 15	.8254E 15	.3021E-02
7500	.9787E 17	.9603E 17	.9372E 14	.8762E 15	.8371E-02
8000	.9175E 17	.8998E 17	.3974E 14	.8691E 15	.2072E-01
8500	.8636E 17	.8466E 17	.1740E 14	.8378E 15	.4670E-01
9000	.8156E 17	.7995E 17	.8057E 13	.7995E 15	.9728E-01
9500	.7727E 17	.7574E 17	.3958E 13	.7611E 15	.1894E 00
10000	.7340E 17	.7195E 17	.2058E 13	.7247E 15	.3476E 00

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-07	.6615E-11
2500	.4658E-05	.6948E-08
3000	.7351E-04	.6884E-06
3500	.5080E-03	.1767E-04
4000	.2085E-02	.1940E-03
4500	.5964E-02	.1193E-02
5000	.1290E-01	.4759E-02
5500	.2170E-01	.1321E-01
6000	.2820E-01	.2608E-01
6500	.2777E-01	.3656E-01
7000	.2098E-01	.3739E-01
7500	.1317E-01	.3050E-01
8000	.7619E-02	.2221E-01
8500	.4359E-02	.1556E-01
9000	.2541E-02	.1086E-01
9500	.1524E-02	.7650E-02
10000	.9416E-03	.5466E-02

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.12955E-01	-.16622E-14
2500	.2011E 01	.1000E 01	.00010	.14988E-02	-.13418E-11
3000	.2035E 01	.1000E 01	.00040	.36103E-03	-.11519E-09
3500	.2077E 01	.1001E 01	.00109	.13215E-03	-.27406E-08
4000	.2141E 01	.1005E 01	.00229	.62824E-04	-.29149E-07
4500	.2225E 01	.1012E 01	.00405	.35594E-04	-.18031E-06
5000	.2329E 01	.1024E 01	.00630	.22872E-04	-.75505E-06
5500	.2449E 01	.1045E 01	.00888	.16206E-04	-.23348E-05
6000	.2583E 01	.1074E 01	.01154	.12479E-04	-.55787E-05
6500	.2731E 01	.1113E 01	.01387	.10381E-04	-.10499E-04
7000	.2890E 01	.1163E 01	.01548	.93004E-05	-.15723E-04
7500	.3061E 01	.1224E 01	.01618	.89002E-05	-.19222E-04
8000	.3244E 01	.1297E 01	.01611	.89368E-05	-.20253E-04
8500	.3439E 01	.1379E 01	.01562	.92209E-05	-.19591E-04
9000	.3648E 01	.1473E 01	.01495	.96296E-05	-.18212E-04
9500	.3873E 01	.1575E 01	.01426	.10098E-04	-.16671E-04
10000	.4115E 01	.1687E 01	.01359	.10595E-04	-.15193E-04

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 18	.3560E 18	.1101E 17	.2838E 09	.1993E-17
2500	.2936E 18	.2848E 18	.8808E 16	.2650E 11	.2716E-13
3000	.2447E 18	.2373E 18	.7339E 16	.5480E 12	.1673E-10
3500	.2097E 18	.2034E 18	.6287E 16	.4772E 13	.1728E-08
4000	.1835E 18	.1780E 18	.5480E 16	.2413E 14	.5791E-07
4500	.1631E 18	.1581E 18	.4806E 16	.8457E 14	.9124E-06
5000	.1468E 18	.1422E 18	.4170E 16	.2276E 15	.8461E-05
5500	.1335E 18	.1290E 18	.3490E 16	.4986E 15	.5338E-04
6000	.1223E 18	.1178E 18	.2725E 16	.9174E 15	.2524E-03
6500	.1129E 18	.1082E 18	.1909E 16	.1436E 16	.9568E-03
7000	.1049E 18	.9986E 17	.1161E 16	.1927E 16	.3048E-02
7500	.9789E 17	.9276E 17	.6145E 15	.2254E 16	.8450E-02
8000	.9177E 17	.8670E 17	.2964E 15	.2385E 16	.2091E-01
8500	.8637E 17	.8147E 17	.1393E 15	.2380E 16	.4711E-01
9000	.8157E 17	.7688E 17	.6677E 14	.2311E 16	.9806E-01
9500	.7728E 17	.7281E 17	.3339E 14	.2218E 16	.1908E 00
10000	.7341E 17	.6915E 17	.1751E 14	.2121E 16	.3499E 00

PRESSURE= .10 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	SPECTRAL LINE INTENSITIES, WATTS/(CC STER) LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-06	.1985E-10
2500	.1397E-04	.2085E-07
3000	.2205E-03	.2065E-05
3500	.1525E-02	.5304E-04
4000	.6274E-02	.5838E-03
4500	.1812E-01	.3624E-02
5000	.4019E-01	.1483E-01
5500	.7157E-01	.4359E-01
6000	.1036E 00	.9583E-01
6500	.1212E 00	.1595E 00
7000	.1133E 00	.2020E 00
7500	.8632E-01	.2000E 00
8000	.5684E-01	.1657E 00
8500	.3488E-01	.1245E 00
9000	.2106E-01	.9000E-01
9500	.1285E-01	.6452E-01
10000	.8010E-02	.4650E-01

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.40967E-01	-.52563E-16
2500	.2011E 01	.1000E 01	.00003	.47399E-02	-.42420E-13
3000	.2035E 01	.1000E 01	.00013	.11422E-02	-.36380E-11
3500	.2077E 01	.1001E 01	.00034	.41885E-03	-.86066E-10
4000	.2141E 01	.1005E 01	.00072	.20086E-03	-.89194E-09
4500	.2225E 01	.1012E 01	.00123	.11724E-03	-.50462E-08
5000	.2329E 01	.1024E 01	.00177	.81514E-04	-.16681E-07
5500	.2449E 01	.1045E 01	.00212	.67809E-04	-.31875E-07
6000	.2583E 01	.1074E 01	.00219	.65711E-04	-.38211E-07
6500	.2731E 01	.1113E 01	.00210	.68636E-04	-.36324E-07
7000	.2890E 01	.1163E 01	.00197	.73156E-04	-.32306E-07
7500	.3061E 01	.1224E 01	.00184	.78135E-04	-.28410E-07
8000	.3244E 01	.1297E 01	.00173	.83255E-04	-.25050E-07
8500	.3439E 01	.1379E 01	.00163	.88422E-04	-.22217E-07
9000	.3648E 01	.1473E 01	.00154	.93608E-04	-.19827E-07
9500	.3873E 01	.1575E 01	.00146	.98801E-04	-.17799E-07
10000	.4115E 01	.1687E 01	.00138	.10400E-03	-.16065E-07

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 19	.1101E 19	.1101E 15	.2838E 08	.1993E-17
2500	.8808E 18	.8807E 18	.8808E 14	.2650E 10	.2715E-13
3000	.7340E 18	.7339E 18	.7235E 14	.5476E 11	.1671E-10
3500	.6291E 18	.6291E 18	.6244E 14	.4750E 12	.1723E-08
4000	.5505E 18	.5504E 18	.5269E 14	.2361E 13	.5764E-07
4500	.4893E 18	.4893E 18	.4114E 14	.7796E 13	.9058E-06
5000	.4404E 18	.4403E 18	.2612E 14	.1792E 14	.8372E-05
5500	.4004E 18	.4003E 18	.1155E 14	.2848E 14	.5262E-04
6000	.3670E 18	.3669E 18	.3610E 13	.3309E 14	.2479E-03
6500	.3388E 18	.3387E 18	.1020E 13	.3285E 14	.9369E-03
7000	.3146E 18	.3145E 18	.3103E 12	.3114E 14	.2981E-02
7500	.2936E 18	.2935E 18	.1058E 12	.2925E 14	.8264E-02
8000	.2753E 18	.2752E 18	.4020E 11	.2748E 14	.2048E-01
8500	.2591F 18	.2590E 18	.1679E 11	.2589E 14	.4622E-01
9000	.2447E 18	.2446E 18	.7610E 10	.2446E 14	.9638E-01
9500	.2318E 18	.2317E 18	.3701E 10	.2317E 14	.1878E 00
10000	.2202E 18	.2202E 18	.1915E 10	.2202E 14	.3450E 00

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-08	.1985E-12
2500	.1397E-06	.2084E-09
3000	.2204E-05	.2064E-07
3500	.1515E-04	.5268E-06
4000	.6032E-04	.5613E-05
4500	.1551E-03	.3102E-04
5000	.2518E-03	.9291E-04
5500	.2369E-03	.1443E-03
6000	.1373E-03	.1269E-03
6500	.6476E-04	.8525E-04
7000	.3028E-04	.5397E-04
7500	.1486E-04	.3443E-04
8000	.7708E-05	.2247E-04
8500	.4206E-05	.1501E-04
9000	.2400E-05	.1026E-04
9500	.1425E-05	.7154E-05
10000	.8758E-06	.5084E-05

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.31128E-01	-.11982E-15
2500	.2011E 01	.1000E 01	.00004	.36015E-02	-.96701E-13
3000	.2035E 01	.1000E 01	.00017	.86776E-03	-.82958E-11
3500	.2077E 01	.1001E 01	.00045	.31797E-03	-.19671E-09
4000	.2141E 01	.1005E 01	.00095	.15189E-03	-.20626E-08
4500	.2225E 01	.1012E 01	.00165	.87442E-04	-.12162E-07
5000	.2329E 01	.1024E 01	.00246	.58625E-04	-.44839E-07
5500	.2449E 01	.1045E 01	.00316	.45503E-04	-.10548E-06
6000	.2583E 01	.1074E 01	.00353	.40796E-04	-.15967E-06
6500	.2731E 01	.1113E 01	.00354	.40711E-04	-.17407E-06
7000	.2890E 01	.1163E 01	.00338	.42642E-04	-.16312E-06
7500	.3061E 01	.1224E 01	.00318	.45276E-04	-.14602E-06
8000	.3244E 01	.1297E 01	.00299	.48141E-04	-.12956E-06
8500	.3439E 01	.1379E 01	.00282	.51089E-04	-.11518E-06
9000	.3648E 01	.1473E 01	.00266	.54067E-04	-.10290E-06
9500	.3873E 01	.1575E 01	.00252	.57057E-04	-.92413E-07
10000	.4115E 01	.1687E 01	.00240	.60054E-04	-.83430E-07

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .0C03

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 19	.1101E 19	.3303E 15	.4915E 08	.1993E-17
2500	.8808E 18	.8805E 18	.2642E 15	.4589E 10	.2715E-13
3000	.7340E 18	.7338E 18	.2201E 15	.9486E 11	.1671E-10
3500	.6291E 18	.6290E 18	.1879E 15	.8243E 12	.1724E-08
4000	.5505E 18	.5503L 18	.1610E 15	.4128E 13	.5768E-07
4500	.4893E 18	.4892E 18	.1328E 15	.1401E 14	.9067E-06
5000	.4404E 18	.4402E 18	.9747E 14	.3464E 14	.8386E-05
5500	.4004E 18	.4002E 18	.5684E 14	.6325E 14	.5274E-04
6000	.3670E 18	.3668E 18	.2423E 14	.8584E 14	.2485E-03
6500	.3388E 18	.3386E 18	.8221E 13	.9338E 14	.9393E-03
7000	.3146E 18	.3144E 18	.2682E 13	.9166E 14	.2988E-02
7500	.2936E 18	.2934E 18	.9365E 12	.8712E 14	.8282E-02
8000	.2753E 18	.2751E 18	.3589E 12	.8219E 14	.2052E-01
8500	.2591E 18	.2589E 18	.1504E 12	.7754E 14	.4629E-01
9000	.2447E 18	.2445E 18	.6828E 11	.7331E 14	.9652E-01
9500	.2318E 18	.2317E 18	.3323E 11	.6948E 14	.1880E 00
10000	.2202E 18	.2201E 18	.1720E 11	.6602E 14	.3454E 00

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2032E 01	.1000E 01	.00001	.23037E-01	-.29558E-15
2500	.2011E 01	.1000E 01	.00005	.26654E-02	-.23857E-12
3000	.2035E 01	.1000E 01	.00022	.64215E-03	-.20472E-10
3500	.2077E 01	.1001E 01	.00061	.23518E-03	-.48619E-09
4000	.2141E 01	.1005E 01	.00128	.11206E-03	-.51360E-08
4500	.2225E 01	.1012E 01	.00225	.63960E-04	-.31076E-07
5000	.2329E 01	.1024E 01	.00344	.41905E-04	-.12278E-06
5500	.2449E 01	.1045E 01	.00465	.30979E-04	-.33429E-06
6000	.2583E 01	.1074E 01	.00559	.25769E-04	-.63359E-06
6500	.2731E 01	.1113E 01	.00601	.23940E-04	-.85603E-06
7000	.2890E 01	.1163E 01	.00598	.24060E-04	-.90818E-06
7500	.3061E 01	.1224E 01	.00574	.25101E-04	-.85693E-06
8000	.3244E 01	.1297E 01	.00543	.26508E-04	-.77607E-06
8500	.3439E 01	.1379E 01	.00513	.28054E-04	-.69560E-06
9000	.3648E 01	.1473E 01	.00486	.29656E-04	-.62354E-06
9500	.3873E 01	.1575E 01	.00460	.31280E-04	-.56088E-06
10000	.4115E 01	.1687E 01	.00437	.32914E-04	-.50675E-06

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 19	.1100E 19	.1101E 16	.8973E 08	.1993E-17
2500	.8808E 18	.8799E 18	.8808E 15	.8379E 10	.2715E-13
3000	.7340E 18	.7333E 18	.7338E 15	.1732E 12	.1671E-10
3500	.6291E 18	.6285E 18	.6276E 15	.1507E 13	.1725E-08
4000	.5505E 18	.5499E 18	.5429E 15	.7584E 13	.5774E-07
4500	.4893E 18	.4888E 18	.4631E 15	.2619E 14	.9082E-06
5000	.4404E 18	.4399E 18	.3725E 15	.6780E 14	.8405E-05
5500	.4004E 18	.3998E 18	.2638E 15	.1365E 15	.5290E-04
6000	.3670E 18	.3664E 18	.1516E 15	.2151E 15	.2495E-03
6500	.3388E 18	.3382E 18	.6845E 14	.2701E 15	.9435E-03
7000	.3146E 18	.3140E 18	.2635E 14	.2879E 15	.3001E-02
7500	.2936E 18	.2930E 18	.9874E 13	.2834E 15	.8314E-02
8000	.2753E 18	.2747E 18	.3890E 13	.2711E 15	.2059E-01
8500	.2591E 18	.2585E 18	.1649E 13	.2572E 15	.4644E-01
9000	.2447E 18	.2442E 18	.7521E 12	.2437E 15	.9679E-01
9500	.2318E 18	.2313E 18	.3670E 12	.2312E 15	.1885E 00
10000	.2202E 18	.2198E 18	.1901E 12	.2198E 15	.3462E 00

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-07	.1985E-11
2500	.1397E-05	.2085E-08
3000	.2205E-04	.2065E-06
3500	.1522E-03	.5295E-05
4000	.6215E-03	.5783E-04
4500	.1746E-02	.3492E-03
5000	.3591E-02	.1325E-02
5500	.5409E-02	.3294E-02
6000	.5767E-02	.5332E-02
6500	.4345E-02	.5720E-02
7000	.2571E-02	.4582E-02
7500	.1387E-02	.3213E-02
8000	.7460E-03	.2174E-02
8500	.4129E-03	.1474E-02
9000	.2372E-03	.1014E-02
9500	.1413E-03	.7092E-03
10000	.8697E-04	.5049E-03

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.17504E-01	-.67379E-15
2500	.2011E 01	.1000E 01	.00007	.20252E-02	-.54386E-12
3000	.2035E 01	.1000E 01	.00030	.48788E-03	-.46679E-10
3500	.2077E 01	.1001E 01	.00081	.17862E-03	-.11097E-08
4000	.2141E 01	.1005E 01	.00169	.84999E-04	-.11770E-07
4500	.2225E 01	.1012E 01	.00298	.48296E-04	-.72181E-07
5000	.2329E 01	.1024E 01	.00461	.31265E-04	-.29563E-06
5500	.2449E 01	.1045E 01	.00640	.22514E-04	-.87082E-06
6000	.2583E 01	.1074E 01	.00806	.17871E-04	-.18994E-05
6500	.2731E 01	.1113E 01	.00923	.15594E-04	-.30970E-05
7000	.2890E 01	.1163E 01	.00972	.14816E-04	-.38893E-05
7500	.3061E 01	.1224E 01	.00964	.14939E-04	-.40648E-05
8000	.3244E 01	.1297E 01	.00928	.15523E-04	-.38644E-05
8500	.3439E 01	.1379E 01	.00883	.16313E-04	-.35380E-05
9000	.3648E 01	.1473E 01	.00838	.17190E-04	-.32014E-05
9500	.3873E 01	.1575E 01	.00795	.18105E-04	-.28922E-05
10000	.4115E 01	.1687E 01	.00756	.19038E-04	-.26186E-05

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 19	.1098E 19	.3303E 16	.1554E 09	.1993E-17
2500	.8808E 18	.8782E 18	.2642E 16	.1451E 11	.2715E-13
3000	.7340E 18	.7318E 18	.2202E 16	.3001E 12	.1672E-10
3500	.6291F 18	.6273E 18	.1885E 16	.2612E 13	.1726E-08
4000	.5505E 18	.5488E 18	.1638E 16	.1318E 14	.5781E-07
4500	.4893E 18	.4878E 18	.1422E 16	.4594E 14	.9099E-06
5000	.4404E 18	.4390E 18	.1199E 16	.1218E 15	.8428E-05
5500	.4004E 18	.3989E 18	.9420E 15	.2584E 15	.5310E-04
6000	.3670E 18	.3655E 18	.6524E 15	.4473E 15	.2507E-03
6500	.3388E 18	.3371E 18	.3780E 15	.6364E 15	.9489E-03
7000	.3146E 18	.3129E 18	.1821E 15	.7593E 15	.3019E-02
7500	.2936E 18	.2919E 18	.7822E 14	.8002E 15	.8365E-02
8000	.2753E 18	.2736E 18	.3290E 14	.7905E 15	.2070E-01
8500	.2591E 18	.2575E 18	.1435E 14	.7606E 15	.4667E-01
9000	.2447E 18	.2432E 18	.6629E 13	.7252E 15	.9723E-01
9500	.2318E 18	.2304E 18	.3255E 13	.6901E 15	.1893E 00
10000	.2202E 18	.2189E 18	.1692E 13	.6569E 15	.3475E 00

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-07	.5954E-11
2500	.4192E-05	.6254E-08
3000	.6616E-04	.6195E-06
3500	.4572E-03	.1590E-04
4000	.1875E-02	.1745E-03
4500	.5360E-02	.1072E-02
5000	.1156E-01	.4265E-02
5500	.1932E-01	.1177E-01
6000	.2481E-01	.2294E-01
6500	.2399E-01	.3159E-01
7000	.1777E-01	.3167E-01
7500	.1099E-01	.2546E-01
8000	.6308E-02	.1839E-01
8500	.3595E-02	.1283E-01
9000	.2091E-02	.8935E-02
9500	.1253E-02	.6292E-02
10000	.7741E-03	.4493E-02

PRESSURE= .30 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.12955E-01	-.16622E-14
2500	.2011E 01	.1000E 01	.00010	.14988E-02	-.13418E-11
3000	.2035E 01	.1000E 01	.00040	.36103E-03	-.11519E-09
3500	.2077E 01	.1001E 01	.00109	.13215E-03	-.27407E-08
4000	.2141E 01	.1005E 01	.00229	.62823E-04	-.29151E-07
4500	.2225E 01	.1012E 01	.00405	.35591E-04	-.18035E-06
5000	.2329E 01	.1024E 01	.00630	.22866E-04	-.75565E-06
5500	.2449E 01	.1045E 01	.00889	.16196E-04	-.23395E-05
6000	.2583E 01	.1074E 01	.01155	.12461E-04	-.56026E-05
6500	.2731E 01	.1113E 01	.01391	.10353E-04	-.10584E-04
7000	.2890E 01	.1163E 01	.01555	.92592E-05	-.15934E-04
7500	.3061E 01	.1224E 01	.01628	.88441E-05	-.19591E-04
8000	.3244E 01	.1297E 01	.01624	.88673E-05	-.20733E-04
8500	.3439E 01	.1379E 01	.01575	.91407E-05	-.20110E-04
9000	.3648E 01	.1473E 01	.01509	.95413E-05	-.18723E-04
9500	.3873E 01	.1575E 01	.01439	.10003E-04	-.17151E-04
10000	.4115E 01	.1687E 01	.01372	.10494E-04	-.15637E-04

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .0100

TEMP CEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 19	.1090E 19	.1101E 17	.2838E 09	.1993E-17
2500	.8808E 18	.8720E 18	.8808E 16	.2650E 11	.2716E-13
3000	.7340E 18	.7267E 18	.7339E 16	.5480E 12	.1673E-10
350C	.6291E 18	.6228E 18	.6287E 16	.4772E 13	.1728E-08
4000	.5505E 18	.5450E 18	.5481E 16	.2413E 14	.5791E-07
4500	.4893E 18	.4844E 18	.4808E 16	.8459E 14	.9124E-06
5000	.4404E 18	.4358E 18	.4174E 16	.2277E 15	.8461E-05
5500	.4004E 18	.3959E 18	.3499E 16	.4993E 15	.5338E-04
6000	.3670E 18	.3624E 18	.2741E 16	.9200E 15	.2524E-03
6500	.3388E 18	.3340E 18	.1929E 16	.1444E 16	.9569E-03
7C00	.3146E 18	.3095E 18	.1182E 16	.1944E 16	.3049E-02
7500	.2936E 18	.2884E 18	.6302E 15	.2283E 16	.8451E-02
8000	.2753E 18	.2701E 18	.3058E 15	.2423E 16	.2091E-01
8500	.2591E 18	.2541E 18	.1442E 15	.2422E 16	.4712E-01
9000	.2447E 18	.2399E 18	.6927E 14	.2354E 16	.9808E-01
9500	.2318E 18	.2272E 18	.3467E 14	.2261E 16	.1908E 00
1C000	.2202E 18	.2159E 18	.1820E 14	.2162E 16	.3499E 00

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .010C

TEMP DEG K	SPECTRAL LINE INTENSITIES,WATTS/(CC STER) LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-06	.1985E-10
2500	.1397E-04	.2085E-07
3000	.2205E-03	.2065E-05
3500	.1525E-02	.5304E-04
4000	.6274E-02	.5838E-03
4500	.1812E-01	.3625E-02
5000	.4023E-01	.1485E-01
5500	.7176E-01	.4371E-01
6000	.1042E 00	.9638E-01
6500	.1225E 00	.1612E 00
7000	.1154E 00	.2056E 00
7500	.8853E-01	.2051E 00
8000	.5864E-01	.1709E 00
8500	.3612E-01	.1289E 00
9000	.2185E-01	.9337E-01
9500	.1335E-01	.6701E-01
10000	.8323E-02	.4831E-01

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.98434E-02	-.37891E-14
2500	.2011E 01	.1000E 01	.00013	.11388E-02	-.30589E-11
3000	.2035E 01	.1000E 01	.00052	.27429E-03	-.26269E-09
3500	.2C77E 01	.1001E 01	.00143	.10037E-03	-.62542E-08
4000	.2141E 01	.1005E 01	.00302	.47688E-04	-.66646E-07
4500	.2225E 01	.1012E 01	.00534	.26972E-04	-.41439E-06
5000	.2329E 01	.1024E 01	.00834	.17259E-04	-.17574E-05
5500	.2449E 01	.1045E 01	.01188	.12118E-04	-.55842E-05
6000	.2583E 01	.1074E 01	.01570	.91727E-05	-.14048E-04
6500	.2731E 01	.1113E 01	.01942	.74142E-05	-.28818E-04
7000	.2890E 01	.1163E 01	.02260	.63718E-05	-.48894E-04
7500	.3061E 01	.1224E 01	.02481	.58047E-05	-.69289E-04
8000	.3244E 01	.1297E 01	.02585	.55703E-05	-.83637E-04
8500	.3439E 01	.1379E 01	.02588	.55626E-05	-.89235E-04
9000	.3648E 01	.1473E 01	.02528	.56957E-05	-.88011E-04
9500	.3873E 01	.1575E 01	.02437	.59083E-05	-.83228E-04
10000	.4115E 01	.1687E 01	.02336	.61632E-05	-.77182E-04

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 19	.1068E 19	.3303E 17	.4915E 09	.1993E-17
2500	.8808E 18	.8544E 18	.2642E 17	.4590E 11	.2716E-13
3000	.7340E 18	.7120E 18	.2202E 17	.9495E 12	.1673E-10
3500	.6291E 18	.6103E 18	.1887E 17	.8272E 13	.1730E-08
4000	.5505E 18	.5339E 18	.1647E 17	.4188E 14	.5803E-07
4500	.4893E 18	.4745E 18	.1453E 17	.1473E 15	.9154E-06
5000	.4404E 18	.4268E 18	.1280E 17	.3997E 15	.8501E-05
5500	.4004E 18	.3875E 18	.1109E 17	.8917E 15	.5372E-04
6000	.3670E 18	.3544E 18	.9262E 16	.1698E 16	.2545E-03
6500	.3388E 18	.3259E 18	.7264E 16	.2816E 16	.9663E-03
7000	.3146E 18	.3012E 18	.5210E 16	.4105E 16	.3084E-02
7500	.2937E 18	.2797E 18	.3351E 16	.5300E 16	.8563E-02
8000	.2753E 18	.2611E 18	.1936E 16	.6139E 16	.2121E-01
8500	.2591E 18	.2450E 18	.1037E 16	.6541E 16	.4777E-01
9000	.2447E 18	.2310E 18	.5383E 15	.6606E 16	.9937E-01
9500	.2319E 18	.2186E 18	.2813E 15	.6480E 16	.1931E 00
10000	.2203E 18	.2076E 18	.1512E 15	.6268E 16	.3539E 00

PRESSURE= .30 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-06	.5954E-10
2500	.4192E-04	.6254E-07
3000	.6616E-03	.6196E-05
3500	.4576E-02	.1592E-03
4000	.1886E-01	.1755E-02
4500	.5476E-01	.1095E-01
5000	.1234E 00	.4553E-01
5500	.2275E 00	.1385E 00
6000	.3522E 00	.3257E 00
6500	.4611E 00	.6070E 00
7C00	.5084E 00	.9060E 00
7500	.4708E 00	.1091E 01
8000	.3713E 00	.1082E 01
8500	.2597E 00	.9269E 00
9000	.1698E 00	.7255E 00
9500	.1083E 00	.5437E 00
10000	.6918E-01	.4016E 00

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00000	.30319E-01	-.12967E-15
2500	.2011E 01	.1000E 01	.00004	.35079E-02	-.10465E-12
3000	.2035E 01	.1000E 01	.00017	.84520E-03	-.89782E-11
3500	.2077E 01	.1001E 01	.00046	.30969E-03	-.21293E-09
4000	.2141E 01	.1005E 01	.00097	.14789E-03	-.22346E-08
4500	.2225E 01	.1012E 01	.00169	.85056E-04	-.13214E-07
5000	.2329E 01	.1024E 01	.00253	.56878E-04	-.49100E-07
5500	.2449E 01	.1045E 01	.00328	.43911E-04	-.11738E-06
6000	.2583E 01	.1074E 01	.00368	.39079E-04	-.18166E-06
6500	.2731E 01	.1113E 01	.00371	.38777E-04	-.20143E-06
7000	.2890E 01	.1163E 01	.00355	.40512E-04	-.19023E-06
7500	.3061E 01	.1224E 01	.00335	.42973E-04	-.17077E-06
8000	.3244E 01	.1297E 01	.00315	.45677E-04	-.15168E-06
8500	.3439E 01	.1379E 01	.00297	.48467E-04	-.13490E-06
9000	.3648E 01	.1473E 01	.00281	.51290E-04	-.12053E-06
9500	.3873E 01	.1575E 01	.00266	.54125E-04	-.10826E-06
10000	.4115E 01	.1687E 01	.00253	.56967E-04	-.97739E-07

PRESSURE= 1.00 ATM. ORIGINAL HOLE FRACTION OF COPPER= .0001

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 19	.3670E 19	.3670E 15	.5181E 08	.1993E-17
2500	.2936E 19	.2936E 19	.2936E 15	.4838E 10	.2715E-13
3000	.2447E 19	.2446E 19	.2446E 15	1.0000E 11	.1671E-10
3500	.2097E 19	.2097E 19	.2088E 15	.8690E 12	.1724E-08
4000	.1835E 19	.1835E 19	.1791E 15	.4355E 13	.5769E-07
4500	.1631E 19	.1631E 19	.1483E 15	.1481E 14	.9068E-06
5000	.1468E 19	.1468E 19	.1100E 15	.3680E 14	.8387E-05
5500	.1335E 19	.1334E 19	.6553E 14	.6792E 14	.5275E-04
6000	.1223E 19	.1223E 19	.2877E 14	.9355E 14	.2486E-03
6500	.1129E 19	.1129E 19	.9985E 13	.1029E 15	.9396E-03
7000	.1049E 19	.1048E 19	.3291E 13	.1016E 15	.2989E-02
7500	.9787E 18	.9785E 18	.1154E 13	.9670E 14	.8284E-02
8000	.9175E 18	.9173E 18	.4427E 12	.9130E 14	.2052E-01
8500	.8635E 18	.8634E 18	.1857E 12	.8616E 14	.4630E-01
9000	.8156E 18	.8154E 18	.8429E 11	.8146E 14	.9654E-01
9500	.7726E 18	.7725E 18	.4103E 11	.7721E 14	.1881E 00
10000	.7340E 18	.7339E 18	.2123E 11	.7337E 14	.3454E 00

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .0C01

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-08	.6615E-12
2500	.4658E-06	.6948E-09
3000	.7349E-05	.6882E-07
3500	.5066E-04	.1762E-05
4000	.2051E-03	.1908E-04
4500	.5590E-03	.1118E-03
5000	.1060E-02	.3912E-03
5500	.1344E-02	.8185E-03
6000	.1094E-02	.1012E-02
6500	.6338E-03	.8344E-03
7000	.3212E-03	.5723E-03
7500	.1621E-03	.3754E-03
8C00	.8488E-04	.2474E-03
8500	.4650E-04	.1660E-03
9000	.2658E-04	.1136E-03
9500	.1579E-04	.7930E-C4
10000	.9713E-05	.5638E-04

PRESSURF= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	INTERNAL PARTITION FUNCTICN		IONIZATICN POTENTIAL	DEBYE	DEBYE
CEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2C02E 01	.1000E 01	.00001	.23037E-01	-.29558E-15
2500	.2011E 01	.1000E 01	.00005	.26654E-02	-.23857E-12
3000	.2035E 01	.1000E 01	.00022	.64215E-03	-.20472E-10
3500	.2077E 01	.1001E 01	.00061	.23518E-03	-.48619E-09
4000	.2141E 01	.1005E 01	.00128	.11206E-03	-.51360E-08
4500	.2225E 01	.1012E 01	.00225	.63960E-04	-.31076E-07
5000	.2329E 01	.1024E 01	.00344	.41904E-04	-.12279E-06
5500	.2449E 01	.1045E 01	.00465	.30976E-04	-.33436E-06
6000	.2583E 01	.1074E 01	.00559	.25765E-04	-.63387E-06
6500	.2731E 01	.1113E 01	.00602	.23934E-04	-.85662E-06
7000	.2890E 01	.1163E 01	.00599	.24053E-04	-.90898E-06
7500	.3061E 01	.1224E 01	.00574	.25092E-04	-.85777E-06
8000	.3244E 01	.1297E 01	.00543	.26499E-04	-.77686E-06
8500	.3439E 01	.1379E 01	.00513	.28045E-04	-.69631E-06
9000	.3648E 01	.1473E 01	.00486	.29645E-04	-.62419E-06
9500	.3873E 01	.1575E 01	.00460	.31269E-04	-.56147E-06
10000	.4115E 01	.1687E 01	.00438	.32903E-04	-.50728E-06

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 19	.3669E 19	.1101E 16	.8973E 08	.1993E-17
2500	.2936E 19	.2935E 19	.8808E 15	.8379E 10	.2715E-13
3000	.2447E 19	.2446E 19	.7338E 15	.1732E 12	.1671E-10
3500	.2097E 19	.2097E 19	.6276E 15	.1507E 13	.1725E-08
4000	.1835E 19	.1834E 19	.5429E 15	.7584E 13	.5774E-07
4500	.1631E 19	.1631E 19	.4631E 15	.2619E 14	.9082E-06
5000	.1468E 19	.1467E 19	.3726E 15	.6780E 14	.8405E-05
5500	.1335E 19	.1334E 19	.2638E 15	.1365E 15	.5290E-04
6000	.1223E 19	.1223E 19	.1517E 15	.2152E 15	.2495E-03
6500	.1129E 19	.1129E 19	.6851E 14	.2702E 15	.9435E-03
7000	.1049E 19	.1048E 19	.2638E 14	.2881E 15	.3001E-02
7500	.9787E 18	.9781E 18	.9886E 13	.2836E 15	.8314E-02
8000	.9175E 18	.9170E 18	.3896E 13	.2713E 15	.2059E-01
8500	.8635E 18	.8630E 18	.1651E 13	.2573E 15	.4644E-01
9000	.8156E 18	.8151E 18	.7532E 12	.2438E 15	.9679E-01
9500	.7726E 18	.7722E 18	.3675E 12	.2314E 15	.1885E 00
10000	.7340E 18	.7336E 18	.1904E 12	.2199E 15	.3462E 00

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-07	.1985E-11
2500	.1397E-05	.2085E-08
3000	.2205E-04	.2065E-06
3500	.1522E-03	.5295E-05
4000	.6215E-03	.5783E-04
4500	.1746E-02	.3492E-03
5000	.3591E-02	.1325E-02
5500	.5411E-02	.3295E-02
6000	.5770E-02	.5335E-02
6500	.4349E-02	.5725E-02
7000	.2574E-02	.4587E-02
7500	.1389E-02	.3218E-02
8000	.7470E-03	.2177E-02
8500	.4135E-03	.1476E-02
9000	.2375E-03	.1015E-02
9500	.1414E-03	.7102E-03
10000	.8709E-04	.5056E-03

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.17049E-01	-.72920E-15
2500	.2011E 01	.1000E 01	.00007	.19725E-02	-.58858E-12
3000	.2035E 01	.1000E 01	.00030	.47519E-03	-.50518E-10
3500	.2077E 01	.1001E 01	.00083	.17397E-03	-.12010E-08
4000	.2141E 01	.1005E 01	.00174	.82778E-04	-.12743E-07
4500	.2225E 01	.1012E 01	.00306	.47018E-04	-.78228E-07
5000	.2329E 01	.1024E 01	.00473	.30411E-04	-.32125E-06
5500	.2449E 01	.1045E 01	.00659	.21857E-04	-.95183E-06
6000	.2583E 01	.1074E 01	.00833	.17287E-04	-.20987E-05
6500	.2731E 01	.1113E 01	.00960	.15003E-04	-.34780E-05
7000	.2890E 01	.1163E 01	.01016	.14169E-04	-.44464E-05
7500	.3061E 01	.1224E 01	.01012	.14224E-04	-.47093E-05
8000	.3244E 01	.1297E 01	.00977	.14744E-04	-.45099E-05
8500	.3439E 01	.1379E 01	.00930	.15477E-04	-.41432E-05
9000	.3648E 01	.1473E 01	.00883	.16300E-04	-.37550E-05
9500	.3873E 01	.1575E 01	.00839	.17164E-04	-.33948E-05
10000	.4115E 01	.1687E 01	.00798	.18046E-04	-.30748E-05

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 19	.3666E 19	.3670E 16	.1638E 09	.1993E-17
2500	.2936E 19	.2933E 19	.2936E 16	.1530E 11	.2715E-13
3000	.2447E 19	.2444E 19	.2446E 16	.3163E 12	.1672E-10
3500	.2097E 19	.2095E 19	.2094E 16	.2753E 13	.1726E-08
4000	.1835E 19	.1833E 19	.1821E 16	.1390E 14	.5782E-07
4500	.1631E 19	.1629E 19	.1583E 16	.4847E 14	.9101E-06
5000	.1468E 19	.1466E 19	.1339E 16	.1287E 15	.8430E-05
5500	.1335E 19	.1333E 19	.1060E 16	.2741E 15	.5312E-04
6000	.1223E 19	.1222E 19	.7448E 15	.4781E 15	.2509E-03
6500	.1129E 19	.1127E 19	.4409E 15	.6876E 15	.9495E-03
7000	.1049E 19	.1047E 19	.2175E 15	.8302E 15	.3022E-02
7500	.9787E 18	.9768E 18	.9510E 14	.8827E 15	.8371E-02
8000	.9175E 18	.9157E 18	.4039E 14	.8762E 15	.2072E-01
8500	.8635E 18	.8618E 18	.1770E 14	.8450E 15	.4670E-01
9000	.8156E 18	.8139E 18	.8199E 13	.8066E 15	.9729E-01
9500	.7726E 18	.7711E 18	.4029E 13	.7678E 15	.1894E 00
10000	.7340E 18	.7325E 18	.2095E 13	.7312E 15	.3476E 00

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .0010

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
CEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-07	.6615E-11
2500	.4658E-05	.6948E-08
3000	.7351E-04	.6884E-06
3500	.5080E-03	.1767E-04
4000	.2085E-02	.1940E-03
4500	.5965E-02	.1193E-02
5000	.1291E-01	.4763E-02
5500	.2174E-01	.1324E-01
6000	.2832E-01	.2619E-01
6500	.2799E-01	.3685E-01
7C00	.2123E-01	.3783E-01
7500	.1336E-01	.3095E-01
8000	.7745E-02	.2257E-01
8500	.4434E-02	.1583E-01
9000	.2586E-02	.1105E-01
9500	.1551E-02	.7786E-02
1C000	.9584E-03	.5563E-02

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.12955E-01	-.16622E-14
2500	.2011E 01	.1000E 01	.00010	.14988E-02	-.13418E-11
3000	.2035E 01	.1000E 01	.00040	.36103E-03	-.11519E-09
3500	.2077E 01	.1001E 01	.00109	.13214E-03	-.27407E-08
4000	.2141E 01	.1005E 01	.00229	.62822E-04	-.29152E-07
4500	.2225E 01	.1012E 01	.00405	.35590E-04	-.18037E-06
5000	.2329E 01	.1024E 01	.00630	.22864E-04	-.75586E-06
5500	.2449E 01	.1045E 01	.00889	.16192E-04	-.23411E-05
6000	.2583E 01	.1074E 01	.01156	.12455E-04	-.56109E-05
6500	.2731E 01	.1113E 01	.01392	.10343E-04	-.10614E-04
7000	.2890E 01	.1163E 01	.01558	.92447E-05	-.16009E-04
7500	.3061E 01	.1224E 01	.01632	.88244E-05	-.19722E-04
8000	.3244E 01	.1297E 01	.01628	.88429E-05	-.20905E-04
8500	.3439E 01	.1379E 01	.01580	.91126E-05	-.20297E-04
9000	.3648E 01	.1473E 01	.01514	.95102E-05	-.18907E-04
9500	.3873E 01	.1575E 01	.01444	.99693E-05	-.17325E-04
10000	.4115E 01	.1687E 01	.01377	.10458E-04	-.15797E-04

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 19	.3659E 19	.1101E 17	.2838E 09	.1993E-17
2500	.2936E 19	.2927E 19	.8808E 16	.2650E 11	.2716E-13
3000	.2447E 19	.2439E 19	.7339E 16	.5480E 12	.1673E-10
3500	.2097E 19	.2091E 19	.6287E 16	.4772E 13	.1728E-08
4000	.1835E 19	.1829E 19	.5481E 16	.2413E 14	.5791E-07
4500	.1631E 19	.1626E 19	.4809E 16	.8459E 14	.9124E-06
5000	.1468E 19	.1463E 19	.4176E 16	.2277E 15	.8461E-05
5500	.1335E 19	.1330E 19	.3503E 16	.4995E 15	.5338E-04
6000	.1223E 19	.1219E 19	.2746E 16	.9209E 15	.2524E-03
6500	.1129E 19	.1124E 19	.1937E 16	.1447E 16	.9569E-03
7000	.1049E 19	.1044E 19	.1190E 16	.1950E 16	.3049E-02
7500	.9787E 18	.9735E 18	.6358E 15	.2293E 16	.8452E-02
8000	.9175E 18	.9123E 18	.3092E 15	.2436E 16	.2092E-01
8500	.8635E 18	.8585E 18	.1460E 15	.2437E 16	.4712E-01
9000	.8156E 18	.8108E 18	.7018E 14	.2369E 16	.9808E-01
9500	.7726E 18	.7681E 18	.3514E 14	.2276E 16	.1908E 00
10000	.7340E 18	.7296E 18	.1844E 14	.2177E 16	.3500E 00

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .0030

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-06	.1985E-10
2500	.1397E-04	.2085E-07
3000	.2205E-03	.2065E-05
3500	.1525E-02	.5304E-04
4000	.6274E-02	.5838E-03
4500	.1812E-01	.3626E-02
5000	.4024E-01	.1485E-01
5500	.7183E-01	.4375E-01
6000	.1044E 00	.9657E-01
6500	.1229E 00	.1618E 00
7000	.1161E 00	.2069E 00
7500	.8932E-01	.2069E 00
8000	.5929E-01	.1728E C0
8500	.3657E-01	.1305E 00
9000	.2213E-01	.9460E-01
9500	.1353E-01	.6791E-01
1C000	.8437F-02	.4898E-01

PRESSURE= 1.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00002	.95875E-02	-.41007E-14
2500	.2011E 01	.1000E 01	.00013	.11092E-02	-.33105E-11
3000	.2035E 01	.1000E 01	.00054	.26715E-03	-.28430E-09
3500	.2077E 01	.1001E 01	.00147	.97759E-04	-.67693E-08
4000	.2141E 01	.1005E 01	.00310	.46443E-04	-.72149E-07
4500	.2225E 01	.1012E 01	.00548	.26264E-04	-.44883E-06
5000	.2329E 01	.1024E 01	.00857	.16799E-04	-.19058E-05
5500	.2449E 01	.1045E 01	.01222	.11785E-04	-.60715E-05
6000	.2583E 01	.1074E 01	.01617	.89057E-05	-.15350E-04
6500	.2731E 01	.1113E 01	.02006	.71781E-05	-.31756E-04
7000	.2890E 01	.1163E 01	.02344	.61426E-05	-.54574E-04
7500	.3061E 01	.1224E 01	.02588	.55645E-05	-.78655E-04
8000	.3244E 01	.1297E 01	.02713	.53073E-05	-.96694E-04
8500	.3439E 01	.1379E 01	.02731	.52723E-05	-.10480E-03
9000	.3648E 01	.1473E 01	.02677	.53789E-05	-.10450E-03
9500	.3873E 01	.1575E 01	.02586	.55674E-05	-.99474E-04
10000	.4115E 01	.1687E 01	.02482	.58003E-05	-.92595E-04

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 19	.3633E 19	.3670E 17	.5181E 09	.1993E-17
2500	.2936E 19	.2907E 19	.2936E 17	.4839E 11	.2716E-13
3000	.2447E 19	.2422E 19	.2447E 17	.1001E 13	.1673E-10
3500	.2097E 19	.2076E 19	.2096E 17	.8720E 13	.1730E-08
4000	.1835E 19	.1817E 19	.1831E 17	.4416E 14	.5804E-07
4500	.1631E 19	.1615E 19	.1615E 17	.1553E 15	.9157E-06
5000	.1468E 19	.1453E 19	.1425E 17	.4219E 15	.8506E-05
5500	.1335E 19	.1320E 19	.1239E 17	.9429E 15	.5375E-04
6000	.1223E 19	.1209E 19	.1041E 17	.1801E 16	.2547E-03
6500	.1129E 19	.1115E 19	.8259E 16	.3004E 16	.9674E-03
7000	.1049E 19	.1034E 19	.6025E 16	.4417E 16	.3089E-02
7500	.9787E 18	.9632E 18	.3962E 16	.5768E 16	.8578E-02
8000	.9176E 18	.9017E 18	.2346E 16	.6763E 16	.2125E-01
8500	.8636E 18	.8478E 18	.1282E 16	.7281E 16	.4787E-01
9000	.8156E 18	.8002E 18	.6755E 15	.7407E 16	.9957E-01
9500	.7727E 18	.7578E 18	.3562E 15	.7298E 16	.1935E 00
10000	.7341E 18	.7197E 18	.1925E 15	.7077E 16	.3545E 00

PRESSURE= 1.00 ATM.   ORIGINAL MOLE FRACTICN OF COPPER= .0100

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
CEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-06	.6615E-10
2500	.4658E-04	.6948E-07
3000	.7352E-03	.6884E-05
3500	.5085E-02	.1769E-03
4000	.2096E-01	.1950E-02
4500	.6089E-01	.1218E-01
5000	.1374E 00	.5070E-01
5500	.2541E 00	.1548E 00
6000	.3960E 00	.3662E 00
6500	.5242E 00	.6901E 00
7000	.5879E 00	.1048E 01
7500	.5566E 00	.1290E 01
8000	.4498E 00	.1311E 01
8500	.3212E 00	.1147E 01
9000	.2130E 00	.9105E 00
9500	.1371E 00	.6885E 00
10000	.8806E-01	.5111E 00

PRESSURE= 1.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00002	.72849E-02	-.93478E-14
2500	.2011E 01	.1000E 01	.00017	.84274E-03	-.75474E-11
3000	.2035E 01	.1000E 01	.00071	.20296E-03	-.64839E-09
3500	.2077E 01	.1001E 01	.00194	.74249E-04	-.15451E-07
4000	.2141E 01	.1005E 01	.00408	.35255E-04	-.16494E-06
4500	.2225E 01	.1012E 01	.00723	.19914E-04	-.10296E-05
5000	.2329E 01	.1024E 01	.01133	.12706E-04	-.44048E-05
5500	.2449E 01	.1045E 01	.01624	.88685E-05	-.14248E-04
6000	.2583E 01	.1074E 01	.02169	.66389E-05	-.37052E-04
6500	.2731E 01	.1113E 01	.02734	.52665E-05	-.80406E-04
7000	.2890E 01	.1163E 01	.03274	.43974E-05	-.14874E-03
7500	.3061E 01	.1224E 01	.03739	.38510E-05	-.23729E-03
8000	.3244E 01	.1297E 01	.04081	.35282E-05	-.32914E-03
8500	.3439E 01	.1379E 01	.04275	.33680E-05	-.40203E-03
9000	.3648E 01	.1473E 01	.04329	.33259E-05	-.44205E-03
9500	.3873E 01	.1575E 01	.04279	.33650E-05	-.45050E-03
10000	.4115E 01	.1687E 01	.04166	.34561E-05	-.43771E-03

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 19	.3560E 19	.1101E 18	.8974E 09	.1993E-17
2500	.2936E 19	.2848E 19	.8808E 17	.8382E 11	.2717E-13
3000	.2447E 19	.2373E 19	.7340E 17	.1734E 13	.1675E-10
3500	.2097E 19	.2034E 19	.6290E 17	.1512E 14	.1732E-08
4000	.1835E 19	.1780E 19	.5497E 17	.7663E 14	.5821E-07
4500	.1631E 19	.1582E 19	.4866E 17	.2702E 15	.9199E-06
5000	.1468E 19	.1423E 19	.4328E 17	.7375E 15	.8560E-05
5500	.1335E 19	.1293E 19	.3832E 17	.1665E 16	.5421E-04
6000	.1223E 19	.1184E 19	.3336E 17	.3241E 16	.2574E-03
6500	.1129E 19	.1090E 19	.2813E 17	.5580E 16	.9801E-03
7000	.1049E 19	.1009E 19	.2258E 17	.8619E 16	.3137E-02
7500	.9789E 18	.9379E 18	.1696E 17	.1204E 17	.8732E-02
8000	.9178E 18	.8754E 18	.1177E 17	.1530E 17	.2167E-01
8500	.8639E 18	.8207E 18	.7538E 16	.1784E 17	.4889E-01
9000	.8159E 18	.7726E 18	.4523E 16	.1937E 17	.1017E 00
9500	.7730E 18	.7304E 18	.2614E 16	.1998E 17	.1975E 00
10000	.7343E 18	.6930E 18	.1497E 16	.1993E 17	.3615E 00

PRESSURE= 1.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-05	.1985E-09
2500	.1397E-03	.2085E-06
3000	.2206E-02	.2065E-04
3500	.1526E-01	.5306E-03
4000	.6293E-01	.5856E-02
4500	.1834E 00	.3669E-01
5000	.4171E 00	.1539E 00
5500	.7859E 00	.4786E 00
6000	.1269E 01	.1173E 01
6500	.1786E 01	.2351E 01
7000	.2204E 01	.3927E 01
7500	.2383E 01	.5521E 01
8000	.2257E 01	.6580E 01
8500	.1888E 01	.6740E 01
9000	.1426E 01	.6096E 01
9500	.1006E 01	.5052E 01
10000	.6848E 00	.3975E 01

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.23037E-01	-.29558E-15
2500	.2011E 01	.1000E 01	.00005	.26654E-02	-.23857E-12
3000	.2035E 01	.1000E 01	.00022	.64215E-03	-.20472E-10
3500	.2077E 01	.1001E 01	.00061	.23518E-03	-.48619E-09
4000	.2141E 01	.1005E 01	.00128	.11206E-03	-.51361E-08
4500	.2225E 01	.1012E 01	.00225	.63960E-04	-.31077E-07
5000	.2329E 01	.1024E 01	.00344	.41903E-04	-.12279E-06
5500	.2449E 01	.1045E 01	.00465	.30976E-04	-.33438E-06
6000	.2583E 01	.1074E 01	.00559	.25764E-04	-.63395E-06
6500	.2731E 01	.1113E 01	.00602	.23933E-04	-.85679E-06
7000	.2890E 01	.1163E 01	.00599	.24051E-04	-.90921E-06
7500	.3061E 01	.1224E 01	.00574	.25090E-04	-.85801E-06
8000	.3244E 01	.1297E 01	.00543	.26496E-04	-.77709E-06
8500	.3439E 01	.1379E 01	.00513	.28042E-04	-.69652E-06
9000	.3648E 01	.1473E 01	.00486	.29642E-04	-.62437E-06
9500	.3873E 01	.1575E 01	.00461	.31266E-04	-.56164E-06
10000	.4115E 01	.1687E 01	.00438	.32899E-04	-.50743E-06

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 20	.1101E 20	.1101E 16	.8973E 08	.1993E-17
2500	.8808E 19	.8807E 19	.8808E 15	.8379E 10	.2715E-13
3000	.7340E 19	.7339E 19	.7338E 15	.1732E 12	.1671E-10
3500	.6291E 19	.6291E 19	.6276E 15	.1507E 13	.1725E-08
4000	.5505E 19	.5504E 19	.5429E 15	.7584E 13	.5774E-07
4500	.4893E 19	.4893E 19	.4631E 15	.2619E 14	.9082E-06
5000	.4404E 19	.4404E 19	.3726E 15	.6780E 14	.8405E-05
5500	.4004E 19	.4003E 19	.2639E 15	.1365E 15	.5290E-04
6000	.3670E 19	.3669E 19	.1517E 15	.2152E 15	.2495E-03
6500	.3388E 19	.3387E 19	.6853E 14	.2702E 15	.9435E-03
7000	.3146E 19	.3145E 19	.2639E 14	.2882E 15	.3001E-02
7500	.2936E 19	.2935E 19	.9890E 13	.2837E 15	.8314E-02
8000	.2753E 19	.2752E 19	.3897E 13	.2713E 15	.2059E-01
8500	.2591F 19	.2590E 19	.1652E 13	.2574E 15	.4644E-01
9000	.2447E 19	.2446E 19	.7535E 12	.2439E 15	.9679E-01
9500	.2318E 19	.2317E 19	.3676E 12	.2314E 15	.1885E 00
10000	.2202E 19	.2202E 19	.1905E 12	.2200E 15	.3462E 00

PRESSURE= 3.00 ATM.   ORIGINAL MOLE FRACTICN OF COPPER= .0001

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-07	.1985E-11
2500	.1397E-05	.2085E-08
3000	.2205E-04	.2065E-06
3500	.1527E-03	.5295E-05
4000	.6215E-03	.5783E-04
4500	.1746E-02	.3492E-03
5000	.3591E-02	.1325E-02
5500	.5411E-02	.3296E-02
6000	.5771E-02	.5336E-02
6500	.4350E-02	.5727E-02
7000	.2575E-02	.4589E-02
7500	.1389E-02	.3219E-02
8000	.7473E-03	.2178E-02
8500	.4137E-03	.1477E-02
9000	.2376E-03	.1016E-02
9500	.1415E-03	.7105E-03
10000	.8713E-04	.5058E-03

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.17504E-01	-.67379E-15
2500	.2011E 01	.1000E 01	.00007	.20252E-02	-.54386E-12
3000	.2035E 01	.1000E 01	.00030	.48788E-03	-.46679E-10
3500	.2077E 01	.1001E 01	.00081	.17862E-03	-.11097E-08
4000	.2141E 01	.1005E 01	.00169	.84999E-04	-.11770E-07
4500	.2225E 01	.1012E 01	.00298	.48295E-04	-.72186E-07
5000	.2329E 01	.1024E 01	.00461	.31263E-04	-.29569E-06
5500	.2449E 01	.1045E 01	.00640	.22511E-04	-.87125E-06
6000	.2583E 01	.1074E 01	.00806	.17865E-04	-.19014E-05
6500	.2731E 01	.1113E 01	.00924	.15585E-04	-.31027E-05
7000	.2890E 01	.1163E 01	.00973	.14802E-04	-.38999E-05
7500	.3061E 01	.1224E 01	.00965	.14922E-04	-.40785E-05
8000	.3244E 01	.1297E 01	.00929	.15504E-04	-.38788E-05
8500	.3439E 01	.1379E 01	.00884	.16292E-04	-.35518E-05
9000	.3648E 01	.1473E 01	.00839	.17167E-04	-.32141E-05
9500	.3873E 01	.1575E 01	.00796	.18081E-04	-.29038E-05
10000	.4115E 01	.1687E 01	.00757	.19013E-04	-.26291E-05

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 20	.1101E 20	.3303E 16	.1554E 09	.1993E-17
2500	.8808E 19	.8805E 19	.2642E 16	.1451E 11	.2715E-13
3000	.7340E 19	.7338E 19	.2202E 16	.3001E 12	.1672E-10
3500	.6291E 19	.6290E 19	.1885E 16	.2612E 13	.1726E-08
4000	.5505E 19	.5503E 19	.1638E 16	.1318E 14	.5781E-07
4500	.4893E 19	.4892E 19	.1422E 16	.4594E 14	.9099E-06
5000	.4404E 19	.4403E 19	.1199E 16	.1218E 15	.8428E-05
5500	.4004E 19	.4002E 19	.9426E 15	.2584E 15	.5310E-04
6000	.3670E 19	.3668E 19	.6532E 15	.4476E 15	.2507E-03
6500	.3388E 19	.3386E 19	.3789E 15	.6372E 15	.9489E-03
7000	.3146E 19	.3144E 19	.1828E 15	.7607E 15	.3019E-02
7500	.2936E 19	.2934E 19	.7857E 14	.8020E 15	.8365E-02
8000	.2753E 19	.2751E 19	.3306E 14	.7925E 15	.2070E-01
8500	.2591E 19	.2589E 19	.1443E 14	.7625E 15	.4667E-01
9000	.2447E 19	.2445E 19	.6664E 13	.7271E 15	.9723E-01
9500	.2318E 19	.2317E 19	.3273E 13	.6919E 15	.1893E 00
10000	.2202E 19	.2201E 19	.1701E 13	.6587E 15	.3475E 00

PRESSURE= 3.0C ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-07	.5954E-11
2500	.4192E-05	.6254E-08
3000	.6616E-04	.6195E-06
3500	.4572E-03	.1590E-04
4000	.1876E-02	.1745E-03
4500	.5360E-02	.1072E-02
5000	.1156E-01	.4266E-02
5500	.1933E-01	.1177E-01
6000	.2484E-01	.2297E-01
6500	.2405E-01	.3166E-01
7000	.1784E-01	.3178E-01
7500	.1104E-01	.2557E-01
8000	.6339E-02	.1848E-01
8500	.3613E-02	.1290E-01
9000	.2102E-02	.8982E-02
9500	.1260E-02	.6325E-02
10000	.7782E-03	.4517E-02

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.12955E-01	-.16622E-14
2500	.2011E 01	.1000E 01	.00010	.14988E-02	-.13418E-11
3000	.2035E 01	.1000E 01	.00040	.36103E-03	-.11519E-09
3500	.2077E 01	.1001E 01	.00109	.13214E-03	-.27407E-08
4000	.2141E 01	.1005E 01	.00229	.62822E-04	-.29152E-07
4500	.2225E 01	.1012E 01	.00405	.35590E-04	-.18038E-06
5000	.2329E 01	.1024E 01	.00630	.22864E-04	-.75592E-06
5500	.2449E 01	.1045E 01	.00889	.16191E-04	-.23416E-05
6000	.2583E 01	.1074E 01	.01156	.12453E-04	-.56133E-05
6500	.2731E 01	.1113E 01	.01392	.10341E-04	-.10622E-04
7000	.2890E 01	.1163E 01	.01553	.92406E-05	-.16030E-04
7500	.3061E 01	.1224E 01	.01633	.88168E-05	-.19760E-04
8000	.3244E 01	.1297E 01	.01630	.88359E-05	-.20955E-04
8500	.3439E 01	.1379E 01	.01581	.91045E-05	-.20351E-04
9000	.3648E 01	.1473E 01	.01515	.95013E-05	-.18960E-04
9500	.3873E 01	.1575E 01	.01446	.99598E-05	-.17375E-04
10000	.4115E 01	.1687E 01	.01378	.10448E-04	-.15844E-04

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 20	.1100E 20	.1101E 17	.2838E 09	.1993E-17
2500	.8808E 19	.8799E 19	.8808E 16	.2650E 11	.2716E-13
3000	.7340E 19	.7333E 19	.7339E 16	.5480E 12	.1673E-10
3500	.6291E 19	.6285E 19	.6287E 16	.4772E 13	.1728E-08
4000	.5505E 19	.5499E 19	.5481E 16	.2413E 14	.5791E-07
4500	.4893E 19	.4888E 19	.4809E 16	.8459E 14	.9124E-06
5000	.4404E 19	.4399E 19	.4176E 16	.2277E 15	.8461E-05
5500	.4004E 19	.3999E 19	.3504E 16	.4996E 15	.5338E-04
6000	.3670E 19	.3665E 19	.2748E 16	.9212E 15	.2524E-03
6500	.3388E 19	.3383E 19	.1939E 16	.1447E 16	.9569E-03
7000	.3146E 19	.3141E 19	.1192E 16	.1952E 16	.3049E-02
7500	.2936E 19	.2931E 19	.6375E 15	.2296E 16	.8452E-02
8000	.2753E 19	.2747E 19	.3102E 15	.2440E 16	.2092E-01
8500	.2591E 19	.2586E 19	.1465E 15	.2442E 16	.4712E-01
9000	.2447E 19	.2442E 19	.7045E 14	.2374E 16	.9809E-01
9500	.2318E 19	.2313E 19	.3527E 14	.2280E 16	.1908E 00
10000	.2202E 19	.2198E 19	.1852E 14	.2181E 16	.3500E 00

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	SPECTRAL LINE INTENSITIES,WATTS/(CC STER) LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-06	.1985E-10
2500	.1397E-04	.2085E-07
3000	.2205E-03	.2065E-05
3500	.1525E-02	.5304E-04
4000	.6274E-02	.5838E-03
4500	.1812E-01	.3626E-02
5000	.4025E-01	.1485E-01
5500	.7185E-01	.4376E-01
6000	.1045E 00	.9663E-01
6500	.1231E 00	.1620E 00
7000	.1163E 00	.2072E 00
7500	.8955E-01	.2075E 00
8000	.5948E-01	.1734E 00
8500	.3670E-01	.1310E 00
9000	.2222E-01	.9495E-01
9500	.1358E-01	.6817E-01
10000	.8470E-02	.4917E-01

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.98434E-02	-.37891E-14
2500	.2011E 01	.1000E 01	.00013	.11388E-02	-.30589E-11
3000	.2035E 01	.1000E 01	.00052	.27429E-03	-.26269E-09
3500	.2077E 01	.1001E 01	.00143	.10037E-03	-.62543E-08
4000	.2141E 01	.1005E 01	.00302	.47687E-04	-.66650E-07
4500	.2225E 01	.1012E 01	.00534	.26970L-04	-.41447E-06
5000	.2329E 01	.1024E 01	.00834	.17255E-04	-.17585E-05
5500	.2449E 01	.1045E 01	.01189	.12112E-04	-.55928E-05
6000	.2583E 01	.1074E 01	.01571	.91624E-05	-.14095E-04
6500	.2731E 01	.1113E 01	.01946	.73982E-05	-.29005E-04
7000	.2890E 01	.1163E 01	.02268	.63480E-05	-.49446E-04
7500	.3061E 01	.1224E 01	.02495	.57710E-05	-.70511E-04
8000	.3244E 01	.1297E 01	.02606	.55255E-05	-.85688E-04
8500	.3439E 01	.1379E 01	.02614	.55073E-05	-.91950E-04
9000	.3648E 01	.1473E 01	.02557	.56317E-05	-.91048E-04
9500	.3873E 01	.1575E 01	.02467	.58372E-05	-.86306E-04
10000	.4115E 01	.1687E 01	.02366	.60863E-05	-.80146E-04

PRESSURE= 3.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 20	.1098E 20	.3303E 17	.4915E 09	.1993E-17
2500	.8808E 19	.8782E 19	.2642E 17	.4590E 11	.2716E-13
3000	.7340E 19	.7318E 19	.2202E 17	.9495E 12	.1673E-10
3500	.6291E 19	.6273E 19	.1887E 17	.8272E 13	.1730E-08
4000	.5505E 19	.5488E 19	.1647E 17	.4188E 14	.5803E-07
4500	.4893E 19	.4879E 19	.1453E 17	.1473E 15	.9154E-06
5000	.4404E 19	.4390E 19	.1281E 17	.3999E 15	.8501E-05
5500	.4004E 19	.3991E 19	.1112E 17	.8927E 15	.5372E-04
6000	.3670E 19	.3657E 19	.9303E 16	.1702E 16	.2545E-03
6500	.3388E 19	.3375E 19	.7327E 16	.2828E 16	.9664E-03
7000	.3146E 19	.3132E 19	.5289E 16	.4136E 16	.3085E-02
7500	.2936E 19	.2922E 19	.3430E 16	.5362E 16	.8565E-02
8000	.2753E 19	.2738E 19	.2000E 16	.6239E 16	.2121E-01
8500	.2591E 19	.2576E 19	.1079E 16	.6673E 16	.4779E-01
9000	.2447E 19	.2433E 19	.5631E 15	.6757E 16	.9941E-01
9500	.2318E 19	.2304E 19	.2953E 15	.6639E 16	.1932E 00
10000	.2202E 19	.2189E 19	.1590E 15	.6428E 16	.3540E 00

PRESSURE= 3.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-06	.5954E-10
2500	.4192E-04	.6254E-07
3000	.6616E-03	.6196E-05
3500	.4576E-02	.1592E-03
4000	.1886E-01	.1755E-02
4500	.5478E-01	.1096E-01
5000	.1235E 00	.4557E-01
5500	.2279E 00	.1388E 00
6000	.3538E 00	.3271E 00
6500	.4651E 00	.6123E 00
7000	.5161E 00	.9197E 00
7500	.4818E 00	.1116E 01
8000	.3835E 00	.1118E 01
8500	.2703E 00	.9646E 00
9000	.1776E 00	.7590E 00
9500	.1136E 00	.5706E 00
10000	.7274E-01	.4222E 00

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00002	.72849E-02	-.93478E-14
2500	.2011E 01	.1000E 01	.00017	.84274E-03	-.75474E-11
3000	.2035E 01	.1000E 01	.00071	.20296E-03	-.64839E-09
3500	.2077E 01	.1001E 01	.00194	.74249E-04	-.15451E-07
4000	.2141E 01	.1005E 01	.00408	.35255E-04	-.16494E-06
4500	.2225E 01	.1012E 01	.00723	.19913E-04	-.10297E-05
5000	.2329E 01	.1024E 01	.01133	.12704E-04	-.44059E-05
5500	.2449E 01	.1045E 01	.01624	.88666E-05	-.14257E-04
6000	.2583E 01	.1074E 01	.02170	.66359E-05	-.37102E-04
6500	.2731E 01	.1113E 01	.02736	.52618E-05	-.80619E-04
7000	.2890E 01	.1163E 01	.03279	.43906E-05	-.14944E-03
7500	.3061E 01	.1224E 01	.03748	.38412E-05	-.23911E-03
8000	.3244E 01	.1297E 01	.04097	.35147E-05	-.33294E-03
8500	.3439E 01	.1379E 01	.04298	.33503E-05	-.40841E-03
9000	.3648E 01	.1473E 01	.04358	.33040E-05	-.45088E-03
9500	.3873E 01	.1575E 01	.04312	.33394E-05	-.46097E-03
10000	.4115E 01	.1687E 01	.04201	.34272E-05	-.44889E-03

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 20	.1090E 20	.1101E 18	.8974E 09	.1993E-17
2500	.8808E 19	.8720E 19	.8808E 17	.8382E 11	.2717E-13
3000	.7340E 19	.7267E 19	.7340E 17	.1734E 13	.1675E-10
3500	.6291E 19	.6229E 19	.6290E 17	.1512E 14	.1732E-08
4000	.5505E 19	.5450E 19	.5497E 17	.7663E 14	.5821E-07
4500	.4893E 19	.4844E 19	.4866E 17	.2702E 15	.9199E-06
5000	.4404E 19	.4359E 19	.4330E 17	.7376E 15	.8560E-05
5500	.4004E 19	.3962E 19	.3835E 17	.1666E 16	.5421E-04
6000	.3670E 19	.3630E 19	.3342E 17	.3244E 16	.2574E-03
6500	.3388E 19	.3348E 19	.2823E 17	.5590E 16	.9801E-03
7000	.3146E 19	.3106E 19	.2273E 17	.8646E 16	.3137E-02
7500	.2936E 19	.2895E 19	.1714E 17	.1210E 17	.8733E-02
8000	.2753E 19	.2710E 19	.1195E 17	.1542E 17	.2168E-01
8500	.2591E 19	.2547E 19	.7698E 16	.1803E 17	.4890E-01
9000	.2447E 19	.2403E 19	.4643E 16	.1963E 17	.1017E 00
9500	.2318E 19	.2275E 19	.2695E 16	.2028E 17	.1976E 00
10000	.2202E 19	.2160E 19	.1548E 16	.2027E 17	.3616E 00

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-05	.1985E-09
2500	.1397E-03	.2085E-06
3000	.2206E-02	.2065E-04
3500	.1526E-01	.5307E-03
4000	.6293E-01	.5856E-02
4500	.1834E 00	.3669E-01
5000	.4173E 00	.1540E 00
5500	.7865E 00	.4790E 00
6000	.1271E 01	.1175E 01
6500	.1792E 01	.2359E 01
7000	.2218E 01	.3952E 01
7500	.2408E 01	.5578E 01
8000	.2292E 01	.6681E 01
8500	.1928E 01	.6882E 01
9000	.1464E 01	.6259E 01
9500	.1037E 01	.5208E 01
10000	.7082E 00	.4111E 01

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
CEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00003	.55352E-02	-.21309E-13
2500	.2011F 01	.1000E 01	.00022	.64031E-03	-.17208E-10
3000	.2035E 01	.1000E 01	.00093	.15418E-03	-.14790E-08
3500	.2077E 01	.1001E 01	.00255	.56387E-04	-.35276E-07
4000	.2141E 01	.1005E 01	.00538	.26759E-04	-.37722E-06
4500	.2225E 01	.1012E 01	.00954	.15100E-04	-.23618E-05
5000	.2329E 01	.1024E 01	.01497	.96162E-05	-.10160E-04
5500	.2449E 01	.1045E 01	.02153	.66890E-05	-.33206E-04
6000	.2583E 01	.1074E 01	.02893	.49769E-05	-.87944E-04
6500	.2731E 01	.1113E 01	.03684	.39083E-05	-.19675E-03
7000	.2890E 01	.1163E 01	.04482	.32122E-05	-.38161E-03
7500	.3061E 01	.1224E 01	.05236	.27497E-05	-.65183E-03
8000	.3244E 01	.1297E 01	.05890	.24444E-05	-.98967E-03
8500	.3439E 01	.1379E 01	.06394	.22519E-05	-.13450E-02
9000	.3648E 01	.1473E 01	.06717	.21437E-05	-.16508E-02
9500	.3873E 01	.1575E 01	.06859	.20994E-05	-.18553E-02
10000	.4115E 01	.1687E 01	.06850	.21021E-05	-.19453E-02

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.1101E 20	.1068E 20	.3303E 18	.1554E 10	.1993E-17
2500	.8808E 19	.8544E 19	.2642E 18	.1452E 12	.2717E-13
3000	.7340E 19	.7120E 19	.2202E 18	.3005E 13	.1676E-10
3500	.6291E 19	.6103E 19	.1887E 18	.2621E 14	.1736E-08
4000	.5505E 19	.5340E 19	.1650E 18	.1330E 15	.5843E-07
4500	.4893E 19	.4746E 19	.1463E 18	.4699E 15	.9254E-06
5000	.4404E 19	.4271E 19	.1308E 18	.1287E 16	.8633E-05
5500	.4004E 19	.3881E 19	.1171E 18	.2927E 16	.5482E-04
6000	.3670E 19	.3554E 19	.1042E 18	.5768E 16	.2611E-03
6500	.3388E 19	.3276E 19	.9120E 17	.1013E 17	.9969E-03
7000	.3146E 19	.3036E 19	.7775E 17	.1615E 17	.3200E-02
7500	.2937E 19	.2826E 19	.6377E 17	.2362E 17	.8936E-02
8000	.2753E 19	.2640E 19	.4977E 17	.3188E 17	.2225E-01
8500	.2592E 19	.2475E 19	.3664E 17	.3991E 17	.5032E-01
9000	.2448E 19	.2329E 19	.2541E 17	.4663E 17	.1049E 00
9500	.2319E 19	.2200E 19	.1672E 17	.5132E 17	.2038E 00
10000	.2203E 19	.2085E 19	.1060E 17	.5389E 17	.3729E 00

PRESSURE= 3.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6278E-05	.5954E-09
2500	.4192E-03	.6254E-06
3000	.6617E-02	.6196E-04
3500	.4578E-01	.1592E-02
4000	.1889E 00	.1758E-01
4500	.5515E 00	.1103E 00
5000	.1261F 01	.4652E 00
5500	.2401E 01	.1463E 01
6000	.3961E 01	.3663E 01
6500	.5789E 01	.7621E 01
7000	.7587E 01	.1352E 02
7500	.8959E 01	.2076E 02
8000	.9543E 01	.2781E 02
8500	.9178E 01	.3276E 02
9000	.8013E 01	.3425E 02
9500	.6434E 01	.3231E 02
10000	.4849E 01	.2815E 02

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.17049E-01	-.72920E-15
2500	.2011E 01	.1000E 01	.00007	.19725E-02	-.58858E-12
3000	.2035E 01	.1000E 01	.00030	.47519E-03	-.50518E-10
3500	.2077E 01	.1001E 01	.00083	.17397E-03	-.12010E-08
4000	.2141E 01	.1005E 01	.00174	.82778E-04	-.12743E-07
4500	.2225E 01	.1012E 01	.00306	.47018E-04	-.78229E-07
5000	.2329E 01	.1024E 01	.00473	.30410E-04	-.32127E-06
5500	.2449E 01	.1045E 01	.00659	.21855E-04	-.95197E-06
6000	.2583E 01	.1074E 01	.00833	.17285E-04	-.20994E-05
6500	.2731E 01	.1113E 01	.00960	.15000E-04	-.34800E-05
7000	.2890E 01	.1163E 01	.01016	.14165E-04	-.44503E-05
7500	.3061E 01	.1224E 01	.01013	.14219E-04	-.47145E-05
8000	.3244E 01	.1297E 01	.00977	.14738E-04	-.45154E-05
8500	.3439E 01	.1379E 01	.00931	.15470E-04	-.41486E-05
9000	.3648E 01	.1473E 01	.00884	.16293E-04	-.37599E-05
9500	.3873E 01	.1575E 01	.00839	.17156E-04	-.33994E-05
10000	.4115E 01	.1687E 01	.00798	.18038E-04	-.30789E-05

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 20	.3670E 20	.3670E 16	.1638E 09	.1993E-17
2500	.2936E 20	.2936E 20	.2936E 16	.1530E 11	.2715E-13
3000	.2447E 20	.2446E 20	.2446E 16	.3163E 12	.1672E-10
3500	.2097E 20	.2097E 20	.2094E 16	.2753E 13	.1726E-08
4000	.1835E 20	.1835E 20	.1821E 16	.1390E 14	.5782E-07
4500	.1631E 20	.1631E 20	.1583E 16	.4847E 14	.9101E-06
5000	.1468E 20	.1468E 20	.1339E 16	.1287E 15	.8430E-05
5500	.1335E 20	.1334E 20	.1060E 16	.2742E 15	.5312E-04
6000	.1223E 20	.1223E 20	.7451E 15	.4782E 15	.2509E-03
6500	.1129E 20	.1129E 20	.4413E 15	.6879E 15	.9495E-03
7000	.1049E 20	.1048E 20	.2178E 15	.8307E 15	.3022E-02
7500	.9787E 19	.9785E 19	.9524E 14	.8833E 15	.8371E-02
8000	.9175E 19	.9173E 19	.4046E 14	.8770E 15	.2072E-01
8500	.8635E 19	.8634E 19	.1773E 14	.8457E 15	.4670E-01
9000	.8156E 19	.8154E 19	.8213E 13	.8073E 15	.9729E-01
9500	.7726E 19	.7725E 19	.4036E 13	.7685E 15	.1894E 00
10000	.7340E 19	.7339E 19	.2099E 13	.7318E 15	.3476E 00

PRESSURE= 10.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0001

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-07	.6615E-11
2500	.4658E-05	.6948E-08
3000	.7351E-04	.6884E-06
3500	.5080E-03	.1767E-04
4000	.2085E-02	.1940E-03
4500	.5965E-02	.1193E-02
5000	.1291E-01	.4764E-02
5500	.2174E-01	.1324E-01
6000	.2834E-01	.2620E-01
6500	.2801E-01	.3688E-01
7000	.2125E-01	.3787E-01
7500	.1338E-01	.3100E-01
8000	.7757E-02	.2261E-01
8500	.4442E-02	.1586E-01
9000	.2590E-02	.1107E-01
9500	.1553E-02	.7800E-02
10000	.9601E-03	.5573E-02

PRESSURE= 10.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
CEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00001	.12955E-01	-.16622E-14
2500	.2011E 01	.1000E 01	.00010	.14988E-02	-.13418E-11
3000	.2035E 01	.1000E 01	.00040	.36103E-03	-.11519E-09
3500	.2077E 01	.1001E 01	.00109	.13214E-03	-.27407E-08
4000	.2141E 01	.1005E 01	.00229	.62822E-04	-.29152E-07
4500	.2225E 01	.1012E 01	.00405	.35590E-04	-.18038E-06
5000	.2329E 01	.1024E 01	.00630	.22863E-04	-.75594E-06
5500	.2449E 01	.1045E 01	.00889	.16190E-04	-.23417E-05
6000	.2583E 01	.1074E 01	.01156	.12453E-04	-.56142E-05
6500	.2731E 01	.1113E 01	.01393	.10340E-04	-.10625E-04
7000	.2890E 01	.1163E 01	.01558	.92392E-05	-.16038E-04
7500	.3061E 01	.1224E 01	.01633	.88168E-05	-.19773E-04
8000	.3244E 01	.1297E 01	.01630	.88334E-05	-.20972E-04
8500	.3439E 01	.1379E 01	.01582	.91017E-05	-.20370E-04
9000	.3648E 01	.1473E 01	.01516	.94982E-05	-.18979E-04
9500	.3873E 01	.1575E 01	.01446	.99564E-05	-.17392E-04
10000	.4115E 01	.1687E 01	.01379	.10444E-04	-.15860E-04

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0003

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 20	.3669E 20	.1101E 17	.2838E 09	.1993E-17
2500	.2936E 20	.2935E 20	.8808E 16	.2650E 11	.2716E-13
3000	.2447E 20	.2446E 20	.7339E 16	.5480E 12	.1673E-10
3500	.2097E 20	.2097E 20	.6287E 16	.4772E 13	.1728E-08
4000	.1835E 20	.1834E 20	.5481E 16	.2413E 14	.5791E-07
4500	.1631E 20	.1631E 20	.4809E 16	.8459E 14	.9124E-06
5000	.1468E 20	.1468E 20	.4176E 16	.2278E 15	.8461E-05
5500	.1335E 20	.1334E 20	.3504E 16	.4996E 15	.5338E-04
6000	.1223E 20	.1223E 20	.2748E 16	.9213E 15	.2524E-03
6500	.1129E 20	.1129E 20	.1940E 16	.1448E 16	.9569E-03
7000	.1049E 20	.1048E 20	.1193E 16	.1953E 16	.3049E-02
7500	.9787E 19	.9781E 19	.6380E 15	.2297E 16	.8452E-02
8000	.9175E 19	.9170E 19	.3105E 15	.2441E 16	.2092E-01
8500	.8635E 19	.8630E 19	.1467E 15	.2443E 16	.4712E-01
9000	.8156E 19	.8151E 19	.7054E 14	.2375E 16	.9809E-01
9500	.7726E 19	.7722E 19	.3532E 14	.2282E 16	.1908E 00
10000	.7340E 19	.7336E 19	.1854E 14	.2183E 16	.3500E 00

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTICN OF COPPER= .0003

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-06	.1985E-10
2500	.1397E-04	.2085E-07
3000	.2205E-03	.2065E-05
3500	.1525E-02	.5304E-04
4000	.6274E-02	.5838E-03
4500	.1813E-01	.3626E-02
5000	.4025E-01	.1485E-01
5500	.7185E-01	.4376E-01
6000	.1045E 00	.9665E-01
6500	.1231E 00	.1621E 00
7000	.1164E 00	.2074E 00
7500	.8963E-01	.2077E 00
8000	.5955E-01	.1736E 00
8500	.3674E-01	.1311E 00
9000	.2225E-01	.9507E-01
9500	.1360E-01	.6827E-01
10000	.8482E-02	.4923E-01

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00002	.95875E-02	-.41007E-14
2500	.2011E 01	.1000E 01	.00013	.11092E-02	-.33105E-11
3000	.2035E 01	.1000E 01	.00054	.26715E-03	-.28430E-09
3500	.2077E 01	.1001E 01	.00147	.97759E-04	-.67693E-08
4000	.2141E 01	.1005E 01	.00310	.46443E-04	-.72150E-07
4500	.2225E 01	.1012E 01	.00548	.26263E-04	-.44886E-06
5000	.2329E 01	.1024E 01	.00857	.16798E-04	-.19062E-05
5500	.2449E 01	.1045E 01	.01222	.11783E-04	-.60745E-05
6000	.2583E 01	.1074E 01	.01617	.89025E-05	-.15366E-04
6500	.2731E 01	.1113E 01	.02007	.71732E-05	-.31821E-04
7000	.2890E 01	.1163E 01	.02347	.61353E-05	-.54769E-04
7500	.3061E 01	.1224E 01	.02592	.55541E-05	-.79096E-04
8000	.3244E 01	.1297E 01	.02720	.52935E-05	-.97455E-04
8500	.3439E 01	.1379E 01	.02740	.52551E-05	-.10583E-03
9000	.3648E 01	.1473E 01	.02687	.53588E-05	-.10568E-03
9500	.3873E 01	.1575E 01	.02597	.55450E-05	-.10069E-03
10000	.4115E 01	.1687E 01	.02493	.57760E-05	-.93771E-04

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 20	.3666E 20	.3670E 17	.5181E 09	.1993E-17
2500	.2936E 20	.2933E 20	.2936E 17	.4839E 11	.2716E-13
3000	.2447E 20	.2444E 20	.2447E 17	.1001E 13	.1673E-10
3500	.2097E 20	.2095E 20	.2096E 17	.8720E 13	.1730E-08
4000	.1835E 20	.1833E 20	.1831E 17	.4416E 14	.5804E-07
4500	.1631E 20	.1629E 20	.1616E 17	.1553E 15	.9158E-06
5000	.1468E 20	.1466E 20	.1426E 17	.4219E 15	.8506E-05
5500	.1335E 20	.1333E 20	.1240E 17	.9432E 15	.5375E-04
6000	.1223E 20	.1222E 20	.1043E 17	.1803E 16	.2547E-03
6500	.1129E 20	.1128E 20	.8281E 16	.3008E 16	.9675E-03
7000	.1049E 20	.1047E 20	.6053E 16	.4428E 16	.3089E-02
7500	.9787E 19	.9771E 19	.3992E 16	.5789E 16	.8578E-02
8000	.9175E 19	.9159E 19	.2370E 16	.6798E 16	.2125E-01
8500	.8635E 19	.8619E 19	.1299E 16	.7329E 16	.4787E-01
9000	.8156E 19	.8140E 19	.6857E 15	.7462E 16	.9958E-01
9500	.7726E 19	.7711E 19	.3620E 15	.7357E 16	.1935E 00
10000	.7340E 19	.7326E 19	.1958E 15	.7137E 16	.3545E 00

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0010

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-06	.6615E-10
2500	.4658E-04	.6948E-07
3000	.7352E-03	.6884E-05
3500	.5085E-02	.1769E-03
4000	.2096E-01	.1950E-02
4500	.6089E-01	.1218E-01
5000	.1374E 00	.5071E-01
5500	.2543E 00	.1549E 00
6000	.3966E 00	.3667E 00
6500	.5257E 00	.6920E 00
7000	.5907E 00	.1053E 01
7500	.5608E 00	.1299E 01
8000	.4545E 00	.1325E 01
8500	.3254E 00	.1162E 01
9000	.2163E 00	.9242E 00
9500	.1394E 00	.6997E 00
10000	.8955E-01	.5198E 00

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00002	.72849E-02	-.93478E-14
2500	.2011E 01	.1000E 01	.00017	.84274E-03	-.75474E-11
3000	.2035E 01	.1000E 01	.00071	.20296E-03	-.64839E-09
3500	.2077E 01	.1001E 01	.00194	.74249E-04	-.15451E-07
4000	.2141E 01	.1005E 01	.00408	.35255E-04	-.16495E-06
4500	.2225E 01	.1012E 01	.00723	.19913E-04	-.10297E-05
5000	.2329E 01	.1024E 01	.01133	.12704E-04	-.44063E-05
5500	.2449E 01	.1045E 01	.01624	.88660E-05	-.14260E-04
6000	.2583E 01	.1074E 01	.02170	.66348E-05	-.37120E-04
6500	.2731E 01	.1113E 01	.02737	.52602E-05	-.80694E-04
7000	.2890E 01	.1163E 01	.03281	.43882E-05	-.14969E-03
7500	.3061E 01	.1224E 01	.03752	.38378E-05	-.23975E-03
8000	.3244E 01	.1297E 01	.04102	.35100E-05	-.33428E-03
8500	.3439E 01	.1379E 01	.04306	.33442E-05	-.41068E-03
9000	.3648E 01	.1473E 01	.04368	.32963E-05	-.45403E-03
9500	.3873E 01	.1575E 01	.04323	.33303E-05	-.46473E-03
10000	.4115E 01	.1687E 01	.04214	.34170E-05	-.45291E-03

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 20	.3659E 20	.1101E 18	.8974E 09	.1993E-17
2500	.2936E 20	.2927E 20	.8808E 17	.8382E 11	.2717E-13
3000	.2447E 20	.2439E 20	.7340E 17	.1734E 13	.1675E-10
3500	.2097E 20	.2091E 20	.6290E 17	.1512E 14	.1732E-08
4000	.1835E 20	.1829E 20	.5497E 17	.7663E 14	.5821E-07
4500	.1631E 20	.1626E 20	.4866E 17	.2702E 15	.9199E-06
5000	.1468E 20	.1464E 20	.4330E 17	.7377E 15	.8560E-05
5500	.1335E 20	.1330E 20	.3837E 17	.1666E 16	.5421E-04
6000	.1223E 20	.1219E 20	.3345E 17	.3245E 16	.2574E-03
6500	.1129E 20	.1125E 20	.2827E 17	.5593E 16	.9802E-03
7000	.1049E 20	.1045E 20	.2278E 17	.8656E 16	.3137E-02
7500	.9787E 19	.9745E 19	.1720E 17	.1212E 17	.8733E-02
8000	.9175E 19	.9132E 19	.1202E 17	.1546E 17	.2168E-01
8500	.8636E 19	.8592E 19	.7755E 16	.1810E 17	.4891E-01
9000	.8156E 19	.8112E 19	.4687E 16	.1972E 17	.1018E 00
9500	.7727E 19	.7683E 19	.2724E 16	.2039E 17	.1976E 00
10000	.7340E 19	.7298E 19	.1567E 16	.2039E 17	.3617E 00

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0030

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-05	.1985E-09
2500	.1397E-03	.2085E-06
3000	.2206E-02	.2065E-04
3500	.1526E-01	.5307E-03
4000	.6293E-01	.5856E-02
4500	.1834E 00	.3669E-01
5000	.4173E 00	.1540E 00
5500	.7868E 00	.4792E 00
6000	.1272E 01	.1176E 01
6500	.1794E 01	.2362E 01
7000	.2223E 01	.3961E 01
7500	.2416E 01	.5598E 01
8000	.2304E 01	.6717E 01
8500	.1942E 01	.6933E U1
9000	.1478E 01	.6317E 01
9500	.1049E 01	.5265E 01
10000	.7166E 00	.4160E 01

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00003	.53913E-02	-.23061E-13
2500	.2011E 01	.1000E 01	.00023	.62366E-03	-.18623E-10
3000	.2035E 01	.1000E 01	.00096	.15017E-03	-.16007E-08
3500	.2C77E 01	.1001E 01	.00262	.54918E-04	-.38184E-07
4000	.2141E 01	.1005E 01	.00553	.26060E-04	-.40838E-06
4500	.2225E 01	.1012E 01	.00979	.14704E-04	-.25577E-05
5000	.2329E 01	.1024E 01	.01538	.93624E-05	-.11009E-04
5500	.2449E 01	.1045E 01	.02212	.65103E-05	-.36017E-04
6000	.2583E 01	.1074E 01	.02974	.48411E-05	-.95559E-04
6500	.2731E 01	.1113E 01	.03791	.37978E-05	-.21441E-03
7000	.2890E 01	.1163E 01	.04620	.31167E-05	-.41778E-03
7500	.3061E 01	.1224E 01	.05409	.26620E-05	-.71843E-03
8000	.3244E 01	.1297E 01	.06103	.23592E-05	-.11009E-02
8500	.3439E 01	.1379E 01	.06651	.21650E-05	-.15136E-02
9000	.3648E 01	.1473E 01	.07017	.20519E-05	-.18824E-02
9500	.3873E 01	.1575E 01	.07197	.20006E-05	-.21439E-02
10000	.4115E 01	.1687E 01	.07216	.19953E-05	-.22747E-02

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 20	.3633E 20	.3670E 18	.1638E 10	.1993E-17
2500	.2936E 20	.2907E 20	.2936E 18	.1530E 12	.2717E-13
3000	.2447E 20	.2422E 20	.2447E 18	.3168E 13	.1676E-10
3500	.2097E 20	.2076E 20	.2097E 18	.2763E 14	.1736E-08
4000	.1835E 20	.1817E 20	.1834E 18	.1402E 15	.5845E-07
4500	.1631E 20	.1615E 20	.1626E 18	.4956E 15	.9260E-06
5000	.1468E 20	.1453E 20	.1454E 18	.1358E 16	.8641E-05
550C	.1335E 20	.1321E 20	.1303E 18	.3090E 16	.5489E-04
6000	.1223E 20	.1211E 20	.1162E 18	.6096E 16	.2615E-03
6500	.1129E 20	.1117E 20	.1021E 18	.1073E 17	.9988E-03
7000	.1049E 20	.1036E 20	.8753E 17	.1716E 17	.3208E-02
7500	.9787E 19	.9665E 19	.7242E 17	.2520E 17	.8960E-02
8000	.9176E 19	.9050E 19	.5719E 17	.3422E 17	.2232E-01
8500	.8637E 19	.8508E 19	.4275E 17	.4318E 17	.5050E-01
9000	.8157E 19	.8025E 19	.3016E 17	.5090E 17	.1053E 00
9500	.7728E 19	.7595E 19	.2019E 17	.5652E 17	.2047E 00
10000	.7342E 19	.7209E 19	.1301E 17	.5981E 17	.3745E 00

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0100

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.6976E-05	.6615E-09
2500	.4658E-03	.6948E-06
3000	.7352E-02	.6884E-04
3500	.5086E-01	.1769E-02
4000	.2099E 00	.1953E-01
4500	.6129E 00	.1226E 00
5000	.1402E 01	.5173E 00
5500	.2673E 01	.1628E 01
6000	.4418E 01	.4085E 01
6500	.6480E 01	.8531E 01
7000	.8542E 01	.1522E 02
7500	.1017E 02	.2357E 02
8000	.1097E 02	.3197E 02
8500	.1071E 02	.3822E 02
9000	.9513E 01	.4065E 02
9500	.7773E 01	.3903E 02
10000	.5951E 01	.3455E 02

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	INTERNAL PARTITION FUNCTION		IONIZATION POTENTIAL	DEBYE	DEBYE
DEG K	CUI	CUII	LOWERING FOR CUI,EV	RADIUS,CM	PRESSURE,ATM
2000	.2002E 01	.1000E 01	.00004	.40965E-02	-.52570E-13
2500	.2011E 01	.1000E 01	.0003C	.47384E-03	-.42462E-10
3000	.2035E 01	.1000E 01	.00126	.11407E-03	-.36521E-08
3500	.2077E 01	.1001E 01	.00345	.41699E-04	-.87223E-07
4000	.2141E 01	.1005E 01	.00728	.19775E-04	-.93469E-06
4500	.2225E 01	.1012E 01	.01292	.11147E-04	-.58712E-05
5000	.2329E 01	.1024E 01	.02032	.70867E-05	-.25385E-04
5500	.2449E 01	.1045E 01	.02929	.49162E-05	-.83640E-04
6000	.2583E 01	.1074E 01	.03954	.36419E-05	-.22445E-03
6500	.2731E 01	.1113E 01	.05070	.28402E-05	-.51266E-03
7000	.2890E 01	.1163E 01	.06233	.23099E-05	-.10262E-02
7500	.3061E 01	.1224E 01	.07394	.19474E-05	-.18349E-02
8000	.3244E 01	.1297E 01	.08492	.16955E-05	-.29660E-02
8500	.3439E 01	.1379E 01	.09469	.15206E-05	-.43686E-02
9000	.3648E 01	.1473E 01	.10268	.14023E-05	-.58980E-02
9500	.3873E 01	.1575E 01	.10849	.13271E-05	-.73439E-02
10000	.4115E 01	.1687E 01	.11199	.12857E-05	-.85025E-02

PRESSURE= 10.00 ATM. ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP DEG K	TOTAL PARTICLES PER CC.	INERT PARTICLES PER CC.	CU ATOMS PER CC.	CU IONS, ELECTRONS PER CC.	EQUILIBRIUM CONSTANT, ATM
2000	.3670E 20	.3560E 20	.1101E 19	.2838E 10	.1993E-17
2500	.2936E 20	.2848E 20	.8808E 18	.2651E 12	.2718E-13
3000	.2447E 20	.2373E 20	.7340E 18	.5490E 13	.1678E-10
3500	.2097E 20	.2034E 20	.6291E 18	.4793E 14	.1741E-08
4000	.1835E 20	.1780E 20	.5503E 18	.2436E 15	.5875E-07
4500	.1631E 20	.1582E 20	.4884E 18	.8624E 15	.9335E-06
5000	.1468E 20	.1424E 20	.4380E 18	.2371E 16	.8741E-05
5500	.1335E 20	.1294E 20	.3948E 18	.5419E 16	.5573E-04
6000	.1223E 20	.1186E 20	.3559E 18	.1077E 17	.2665E-03
6500	.1129E 20	.1094E 20	.3190E 18	.1919E 17	.1022E-02
7000	.1049E 20	.1014E 20	.2824E 18	.3124E 17	.3295E-02
7500	.9788E 19	.9449E 19	.2452E 18	.4709E 17	.9240E-02
8000	.9178E 19	.8838E 19	.2071E 18	.6627E 17	.2311E-01
8500	.8639E 19	.8295E 19	.1690E 18	.8754E 17	.5248E-01
9000	.8160E 19	.7810E 19	.1326E 18	.1090E 18	.1098E 00
9500	.7732E 19	.7375E 19	.9968E 17	.1284E 18	.2140E 00
10000	.7346E 19	.6986E 19	.7202E 17	.1441E 18	.3922E 00

PRESSURE= 10.00 ATM.   ORIGINAL MOLE FRACTION OF COPPER= .0300

TEMP	SPECTRAL LINE INTENSITIES,WATTS/(CC STER)	
DEG K	LAMBDA 5105.5	LAMBDA 5153.2
2000	.2093E-04	.1985E-08
2500	.1397E-02	.2085E-05
3000	.2206E-01	.2065E-03
3500	.1526E 00	.5307E-02
4000	.6299E 00	.5861E-01
4500	.1841E 01	.3683E 00
5000	.4221E 01	.1558E 01
5500	.8096E 01	.4931E 01
6000	.1354E 02	.1252E 02
6500	.2025E 02	.2666E 02
7000	.2756E 02	.4911E 02
7500	.3444E 02	.7979E 02
8000	.3971E 02	.1157E 03
8500	.4233E 02	.1511E 03
9000	.4180E 02	.1787E 03
9500	.3837E 02	.1926E 03
10000	.3294E 02	.1912E 03

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$COMPILE MAD,EXECUTE,PRINT OBJECT,DUMP,COPIES(3)                010839   05/09/64     11 00 29.0 AM

MAD (12 MAR 1964 VERSION) PROGRAM LISTING ... ... ...

             CALCULATION OF SELF-CONSISTANT PARTITION FCN, EQUILIBRIUM CON
             STANT, SPECIES CONCENTRATION AND SELECTED SPECTRAL LINE INTEN
               SITIES FROM COPPER VAPOR IN A HOT INERT GAS.
              READ DATA V,JI, EI,     JII,EII,EION1,EION2, LAM(1)...LAM(2),     *001
             GA(1)...GA(2), EN(1)...EN(2)
                IQ=0                                                            *002
                IR=0                                                            *003
                IS=0                                                            *004
                THROUGH EPSI, FOR VALUES OF P=.03,.1,.3,1.,3.,10.               *005
                IQ=IQ+1                                                         *006
                THROUGH EPSI, FOR VALUES OF N=.0001,.0003,.001,.003,.01,        *007
            1   .03                                                             *007
                WHENEVER IR.GE.6, IR=0                                          *008
                IR=IR+1                                                         *009
                THROUGH EPSI,  FOR            T=2000., 500.,T.G.10000.          *010
                WHENEVER IS.GE.17,  IS=0                                        *011
                IS=IS+1                                                         *012
                IE=0                                                            *013
                DEBYE(0)=0.                                                     *014
PAR1            THROUGH BETA,  FOR I=1,1,I.G.  67                               *015
              WHENEVER EI(I).E.CORE,TRANSFER TO DELTA                           *016
              AI(I)=(2.*JI(I)+1.)*EXP.(-EI(I)*1.4388/T)                         *017
                WHENEVER IE.E.0                                                 *018
              WHENEVER AI (I).L.(1.E-6),  TRANSFER TO DELTA                     *019
                OTHERWISE                                                       *020
                WHENEVER  EI(I).G.ED1                                           *021
            1   .OR.(AI(I).L.(1.E-6)), TRANSFER TO DELTA                        *021
BETA            END OF CONDITIONAL                                              *022
DELTA        ZI=0.                                                              *023
              THROUGH GAMMA, FOR IN=1,1,IN.G.I                                  *024
GAMMA         ZI=ZI+AI(IN)                                                      *025
                THROUGH  ETA,  FOR  II=1,1,II.G.25                              *026
              WHENEVER EII(II).E.CORE,TRANSFER TO ELTA                          *027
              AII(II)=(2.*JII(II)+1.)*EXP.(-EII(II)*1.4388/T)                   *028
                WHENEVER  IE.E.0                                                *029
              WHENEVER AII(II).L.(1.E-6), TRANSFER TO ELTA                      *030
                OTHERWISE                                                       *031
                WHENEVER EII(II).G.ED2                                          *032
            1  .OR  .(AII(II).L. 1.E-6),  TRANSFER TO ELTA                      *032
ETA           END OF CONDITIONAL                                                *033
ELTA          ZII=0.                                                            *034
              THROUGH AMMA, FOR IX=1,1,IX.G.II                                  *035
AMMA          ZII=ZII+AII(IX)                                                   *036
                    WHENEVER IE.E.0                                             *037
                 VION=V                                                         *038
                OTHERWISE                                                       *039
                DELV=(1.43987 E-7)/DEBYE(IE)                                    *040
               VION=V -DCLV                                                     *041
                END OF CONDITIONAL                                              *042
                LGKP=  .4342945*ELOG.( 2.*ZII/ZI ) -5040.16*VION/T+1.085736     *043
            1   *ELOG.(T) -6.48284                                              *043
              KP=EXP.(2.302585*LGKP)                                            *044
                C= 4.*P*N/  (KP*((N+1.). P.2))                                  *045
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         WHENEVER   C.LE..040                                           *046
         XE=(2.*P/(M+1.))*(.5-.125*C+ +.0625*C*C)                       *047
         OTHERWISE                                                      *048
         XE=(KP*(M+1.)/(2.*P))*(SQRT.(1.*C)-1.)                         *049
         END OF CONDITIONAL                                             *050
         N(1)=.734002E22*P/T                                            *051
         THROUGH NEWT,FOR I=1,1, I.G.6                                  *052
         N(I+1)=N(I)-(N(1)+(1.1415E-4)*((XE*N(I)/T).P.1.5)-N(I))        *053
       1 /((1.71225E-4)*((XE/T).P.1.5)*SQRT.(N(I))-1.)                  *053
NEWT     WHENEVER  .ABS. (1.- N(I+1) /N(I)).L.1.E-5, TRANSFER TO        *054
       1 SKIP                                                           *054
SKIP     NT=N(I+1)                                                      *055
        NE=XE*NT                                                        *056
         IE=IE+1                                                        *057
         DEBYE( IE ) = 4.87965*SQRT.( T/NE)                             *058
         ED1=EION1-(1.1614E-3)/DEBYE(IE)                                *059
         ED2=EION2-(2.3228E-3)/DEBYE(IE)                                *060
         WHENEVER(.ABS.(1.-DEBYE( IE -1)/DEBYE( IE )).GE. 1.E-5)        *061
       1 .AND.( IE  .L. 5), TRANSFER TO PAR1                            *061
         PDEB=-(1.80693E-24)*T/(DEBYE(IE).P.3)                          *062
         XNEU= M-XE*(M+1.)                                              *063
         NNEU=NT*XNEU                                                   *064
         XIN=1.-(2.*XE+XNEU)                                            *065
         NIN=NT*XIN                                                     *066
         THROUGH SWB,  FOR A=1,1, A.G.2                                 *067
         NU(A)= (2.99793E18) /( 1.00027*LAM(A)+.04)                     *068
SWB      INT(A)= (( 6.62517E -27)*NU(A)/12.5664)*(1.E-7)*NNEU*GA(A)*    *069
       1 EXP.( -1.4388*EN(A)/T)/ZI                                      *069
         SP   (IQ,IR,IS  )=P                                            *070
         SM   (IQ,IR,IS  )=M                                            *071
         ST   (IQ,IR,IS  )=T                                            *072
         SNT  (IQ,IR,IS  )=NT                                           *073
         SNIN (IQ,IR,IS  )=NIN                                          *074
         SNEU (IQ,IR,IS  )=NNEU                                         *075
         SNE  (IQ,IR,IS  )=NE                                           *076
         SKP  (IQ,IR,IS  )=KP                                           *077
         SIT1 (IQ,IR,IS  )=INT(1)                                       *078
         SIT2 (IQ,IR,IS  )=INT(2)                                       *079
         WHENEVER IS.E.1,  PRINT FORMAT TIT1, P,M                       *080
EPSI     PRINT FORMAT ANS1,T,  ZI  ,ZII,DELV,                           *081
       1  DEBYE(IE),PDEB                                                *081
         THROUGH PRT1  ,FOR IQ  =1,1, IQ.G.6                            *082
         THROUGH PRT1  ,FOR IR  =1,1, IR.G.6                            *083
         THROUGH PRT1  ,FOR IS  =1,1, IS.G.17                           *084
         WHENEVER IS .E. 1, PRINT FORMAT  TIT2 ,   SP(IQ,IR, IS),       *085
       1 SM(IQ,IR,IS)                                                   *085
PRT1     PRINT FORMAT ANS2, ST(IQ,IR,IS),SNT(IQ,IR,IS),SNIN(IQ,IR,IS    *086
       1 ),SNEU(IQ,IR,IS),SNE(IQ,IR,IS),SKP(IQ,IR,IS)                   *086
         THROUGH PRT3  ,FOR IQ  =1,1, IQ.G.6                            *087
         THROUGH PRT3  ,FOR IR  =1,1, IR.G.6                            *088
         THROUGH PRT3  ,FOR IS  =1,1, IS.G.17                           *089
         WHENEVER IS .E. 1, PRINT FORMAT  TIT3 ,   SP(IQ,IR, IS),       *090
       1 SM(IQ,IR,IS) ,LAM(1)  ,LAM(2)                                  *090
PRT3     PRINT FORMAT ANS3, ST(IQ,IR,IS),SIT1(IQ,IR,IS),SIT2(IQ,IR,I    *091
       1 S)                                                             *091
         VECTOR VALUES   VSP  = 3,1,6,19                                *092
         VECTOR VALUES   VSM  = 3,1,6,19                                *093
         VECTOR VALUES   VST  = 3,1,6,19                                *094
         VECTOR VALUES   VSNT = 3,1,6,19                                *095
         VECTOR VALUES   VSNIN= 3,1,6,19                                *096
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     VECTOR VALUES   VSNE = 3,1,6,19                                   *097
     VECTOR VALUES   VSNEU= 3,1,6,19                                   *098
     VECTOR VALUES   VSKP = 3,1,6,19                                   *099
     VECTOR VALUES   VSIT1= 3,1,6,19                                   *100
     VECTOR VALUES   VSIT2= 3,1,6,19                                   *101
   VECTOR VALUES TIT1=$1H1,S20,9HPRESSURE=F6.2,5H ATM.,S5,33HORI       *102
 1 GINAL MOLE FRACTION OF COPPER=F6.4//                                *102
 2 S13,4HTEMP,S6,27HINTERNAL PARTITION FUNCTION,S6,20HIONIZATION       *102
 3  POTENTIAL,S7, 5HDEBYE,S12,5HDEBYE//                                *102
 4 S13,5HDEG K,S9,3HCUI,S12,4HCUII,S10,19HLOWERING FOR CUI,EV          *102
 5 ,S8,9HRADIUS,CM,S8,12HPRESSURE,ATM *$                               *102
   VECTOR VALUES TIT2=$1H1,S20,9HPRESSURE=F6.2,5H ATM.,S5,33HORI       *103
 1 GINAL MOLE FRACTION OF COPPER=F6.4//                                *103
 2 S13,4HTEMP,S7,5HTOTAL,S10,5HINERT,S10,2HCU,S13,8HCU IONS,S7,        *103
 3 11HEQUILIBRIUM//                                                    *103
 4 S13,5HDEG K,S6,9HPARTICLES,S6,9HPARTICLES,S6,5HATOMS,S10,9HEL       *103
 5 ECTRONS,S6,9HCONSTANT,//                                            *103
 6 S24,7HPER CC.,S8,7HPER CC.,S8,7HPER CC.,S8,7HPER CC.,S8,3HATM       *103
 7 .//*$                                                               *103
   VECTOR VALUES TIT3=$1H1,S20,9HPRESSURE=F6.2,5H ATM.,S5,33HORI       *104
 1 GINAL MOLE FRACTION OF COPPER=F6.4//                                *104
 2 S13,4HTEMP,S7,41HSPECTRAL LINE INTENSITIES,WATTS/(CC STER)//        *104
 3 S13,5HDEG K,S6,6HLAMBDA,F7.1,S6,6HLAMBDA,F7.1//*$                   *104
   VECTOR VALUES ANS1= $1H0,S10,F7.0,2E15.4,F18.5,E26.5,E20.5*$        *105
   VECTOR VALUES ANS2= $1H0,S10,F7.0,5E15.4 *$                         *106
   VECTOR VALUES ANS3= $1H0,S10,F7.0, E18.4,E19.4*$                    *107
     DIMENSION JI(100),EI(100),         JII(100),EII(100),LAM(3        *108
 1   ),GA(3),EN(3),DEBYE(6),INT(3),NU(3),SP(684,VSP),SM( 684,VSM       *108
 2   ),ST(684,VST),SNT(684,VSNT),SNIN(684,VSNIN),SNEU (684,VSNEU       *108
 3   ),SNE(684,VSNE),SKP(684,VSKP),SIT1(684,VSIT1),SIT2(684,VSIT       *108
 4   2),AI(100),AII(100),N(10)                                         *108
   PRINT COMMENT $1           J AND E VALUES USED $                    *109
   PRINT RESULTS JI(1)...JI(67),EI(1)...EI(67),                        *110
 1   JII(1)...JII(25),EII(1)...EII(25)                                 *110
   PRINT COMMENT $1          DATA FOR COPPER$                          *111
   PRINT RESULTS V,EION1,EION2,LAM(1),GA(1),EN(1),LAM(2),GA(2),        *112
 1 EN(2)                                                               *112
     INTEGER IQ,IR,IS,IE,I,IN,II,IX,A                                  *113
     END OF PROGRAM                                                    *114
```

J AND E VALUES USED

JI(1)...JI(67)

5.000000E-01	2.500000E 00	1.500000E 00	5.000000E-01	1.500000E 00	2.500000E 00	1.500000E 00	5.000000E-01
4.500000E 00	3.500000E 00	2.500000E 00	1.500000E 00	5.000000E-01	3.500000E 00	2.500000E 00	1.500000E 00
5.000000E-01	2.500000E 00	3.500000E 00	5.000000E-01	1.500000E 00	1.500000E 00	2.500000E 00	1.500000E 00
5.000000E-01	1.500000E 00	2.500000E 00	5.000000E-01	1.500000E 00	5.000000E-01	1.500000E 00	2.500000E 00
3.500000E 00	2.500000E 00	3.500000E 00	2.500000E 00	1.500000E 00	5.000000E-01	2.500000E 00	1.500000E 00
5.000000E-01	5.000000E-01	1.500000E 00	1.500000E 00	2.500000E 00	2.500000E 00	3.500000E 00	5.000000E-01
1.500000E 00	2.500000E 00	1.500000E 00	5.000000E-01	5.000000E-01	1.500000E 00	2.500000E 00	1.500000E 00
5.000000E-01	1.500000E 00	2.500000E 00	1.500000E 00	5.000000E-01	1.500000E 00	2.500000E 00	1.500000E 00
5.000000E-01	1.500000E 00	2.500000E 00					

EI(1)...EI(67)

.000000E 00	1.120260E 04	1.324540E 04	3.053530E 04	3.078370E 04	3.901870E 04	4.011400E 04	4.094370E 04
4.090910E 04	4.115343E 04	4.156290E 04	4.230250E 04	4.313720E 04	4.351400E 04	4.440630E 04	4.454420E 04
4.491560E 04	4.372620E 04	4.496320E 04	4.582100E 04	4.587930E 04	4.617280E 04	4.659830E 04	4.938300E 04
4.938330E 04	4.993520E 04	4.994210E 04	5.284870E 04	5.478410E 04	5.502770E 04	5.538770E 04	5.539130E 04
5.542630E 04	5.542980E 04	5.603000E 04	5.811930E 04	5.634370E 04	5.836470E 04	5.665150E 04	5.869090E 04
5.667140E 04	5.741930E 04	5.794870E 04	5.789310E 04	5.789510E 04	5.790520E 04	5.790870E 04	5.856890E 04
5.924950E 04	5.925070E 04	5.927530E 04	5.932320E 04	5.964790E 04	6.006550E 04	6.006630E 04	6.007060E 04
6.008520E 04	6.059450E 04	6.059510E 04	6.059500E 04	6.060190E 04	6.095690E 04	6.095740E 04	6.095800E 04
6.095800E 04	6.121560E 04	6.121560E 04					

JII(1)...JII(25)

.000000E 00	2.000000E 00	3.000000E 00	1.000000E 00	2.000000E 00	2.000000E 00	1.000000E 00	.000000E 00
4.000000E 00	3.000000E 00	2.000000E 00	4.000000E 00	3.000000E 00	2.000000E 00	3.000000E 00	2.000000E 00
1.000000E 00	3.000000E 00	2.000000E 00	1.000000E 00	2.000000E 00	2.000000E 00	1.000000E 00	.000000E 00
4.000000E 00							

EII(1)...EII(25)

.000000E 00	2.192860E 04	2.284700E 04	2.399830E 04	2.626450E 04	6.641870E 04	6.791660E 04	6.885030E 04
6.873080E 04	6.844780E 04	6.986810E 04	6.970480E 04	7.153150E 04	7.272400E 04	7.084150E 04	7.149390E 04
7.310210E 04	7.192010E 04	7.335340E 04	7.359590E 04	8.538880E 04	8.836200E 04	8.860520E 04	8.892610E 04
9.556570E 04							

```
DATA FOR COPPER
     V =       7.725880,         EION1 =  6.231720E 04,      EION2 =  1.636656E 05,      LAM(1) =   5105.539978
 GA(1) =  5.100000E 06,          EN(1) =  3.078370E 04,     LAM(2) =   5153.239990,       GA(2) =  4.700000E 08
 EN(2) =  4.993520E 04
```

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(Contract SD-91) Unclassified report

The self-consistent partition function; ionization potential lowering; electron, ion, and neutral-particle species concentrations; and the absolute spectral-line intensities of Cu I λ 5106 and Cu I λ 5153 are reviewed and tabulated for pressures between 0.03 and 10 atm, for original mole fractions between 10^{-4} and 0.03 and for temperatures from 2000° to 10,000°K, for copper vapor in a hot inert gas at thermal equilibrium. Only single ionization of copper is considered in this range of conditions. For
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